CONSTRUCTION STANDARDS

For

Water Utilities within Subdivisions

and rights of way

Graham County Electric Cooperative, Inc.

9 W Center Street

Pima, Arizona 85543

www.gce.coop

Document Control and Executive Release Requirements

One-sentence assessment: This construction standards document contains substantial operational and technical detail, but it requires governance controls, consistent authority references, and final technical validation before it should be issued for contractor or inspector use.
Authority and applicability: Unless otherwise stated in an approved project-specific supplement, Graham County Electric Cooperative, Inc. and its designated water utility representatives are the controlling authority for interpretation, approval, inspection, acceptance, and enforcement of these standards.
External references: References to other agencies, manuals, details, counties, municipalities, or standards shall be treated as technical source references only and shall not override GCEC requirements unless expressly adopted in writing for the project.
Release condition: This document shall not be issued as a final standard until all highlighted text, incomplete citations, appendix references, standard detail references, test methods, and jurisdiction-specific requirements have been verified and approved by the document owner.

Executive Improvement Action Register		
Improvement Area	**Required Action**	**Release Impact**
Governance and Source Control	Confirm a single document owner, approval authority, revision history, and controlled distribution process before release.	Prevents uncontrolled edits, conflicting interpretations, and unauthorized field use.
Structure and Usability	Standardize headings, section numbering, table titles, terminology, and repeated provisions across the document.	Improves contractor usability and inspector enforceability.
Technical Risk and Compliance	Validate all highlighted provisions, incomplete references, appendix citations, test methods, and external agency requirements.	Reduces construction disputes, failed inspections, and compliance risk.

Revision History

Version	Date	Description	Prepared By	Approved By
Draft	Pending	Governance, authority, usability, and technical validation controls added for executive review.	GCEC Water	Pending

Approval Block

Role	Name	Signature	Date
Document Owner			
Engineering Approval			
Operations Approval			
Executive Approval			

MAINTENANCE

GENERAL

Description of Work. The work under this Section shall consist of providing flagging services and furnishing, installing, maintaining, moving, and removing barriers, barricades, warning signs, delineators, lights, signals, cones, pavement markings, and other traffic control devices in order to provide safe and efficient passage through and/or around the work, as well as protect the public and workers from damage to person and property within the limits and for the duration of the project. The work shall also consist of sweeping, roadway and subgrade repair, safety feature repair, debris removal, repair of pedestrian features, and other work necessary to provide a smooth and safe traveled way. Cost is incidental unless otherwise noted on the plans, special provisions, or contract.

A. **Maintenance and Protection of Traffic**. All work shall conform to the requirements of the current issue of the Work Zone Standards and Guidelines published by the U.S. Department of Transportation, Federal Highway Administration, as amended by the appropriate agency in whose jurisdiction the work is being done, and hereinafter referred to as the traffic control standards. The requirements of the traffic control standards shall be considered the minimum standards for the protection of workers and the public.

   Traffic shall be maintained over a reasonably smooth and safe traveled way that shall be so marked by signs, delineators, guiding devices, and other methods such that a person who has no knowledge of conditions may safely—and with a minimum of discomfort and inconvenience— ride, drive, or walk, day or night, over all or any portion of the work where traffic is to be maintained.

The Contractor shall give 2-day advance notice of construction activities to affected public and/or private agencies or businesses that utilize the roadways or easements within construction areas. Affected public and/or private agencies or businesses shall include, but are not limited to:

- Law enforcement
- Fire protection
- Postal service
- School districts
- Transit systems
- Garbage collections

Upon request by GCEC or the governing jurisdiction, the Contractor shall provide written notification of construction activities to GCEC and affected parties.

B. Maintenance of the Project Site. Throughout all phases of work, and until final acceptance of the project, the Contractor shall keep the work area clean and free from rubbish, excess materials, and debris generated by construction activities. The Contractor shall employ all appropriate methods and procedures required to prevent any dust nuisance resulting from the project. Dust control measures shall be maintained at all times, in accordance with ADEQ air quality regulations. All holes resulting from the work, regardless of size, are to be barricaded on all sides. This includes, but is not limited to:

a. Trenches
b. Service connections
c. Tapping sleeve and valve installations
d. Tie-in connections
e. Flush points
f. Fire hydrant pits
g. Excavations for boring equipment

Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location and shall not move them until directed. The Contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing the work, or at any time due to defective work or materials, and said responsibility will not be released until the project shall have been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof by the Contractor, the Contractor shall restore, at no cost to GCEC, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner. Such damage will include but not be limited to landscaped areas. The Contractor shall re-grade the disturbed area as directed and restore the surface material to match existing in type and quality.

When construction is within temporary construction easements, the Contractor shall restore all disturbed areas to a condition equal to or better than the existing improvements. Such restoration will include but not be limited to asphalt, walkways, fences, lights, sprinklers, landscaping, etc. In the case of landscaping, the Contractor may remove and store sod and plant material. If, in the determination of the Engineer, the sod and/or plant material did not survive the transplanting in good condition, the Contractor shall replace the sod and/or plant material to match in type and quality. In addition, the Contractor may salvage any sprinkler system materials, lighting materials, etc. In the

event that it is not feasible to reinstall the salvaged material, new material shall be installed.

The Contractor shall not dump spoil or waste material on private property without first obtaining written permission from the property owner. All such dumping shall comply with applicable grading, drainage, environmental, and jurisdictional requirements.

Access to private property shall be maintained to keep inconvenience to the property owner to a minimum. Prior to any construction in front of driveways, the Contractor shall notify the property owner 24 hours in advance. Inconvenience caused by construction across driveways and sidewalks shall be kept to a minimum by restoring the serviceability as soon as possible. If it is necessary to leave open excavation for a long period of time, the Contractor shall provide structurally adequate steel plates to bridge the excavation.

No pay estimates shall be approved until the construction site complies with this Paragraph.

C. Maintenance Directed by the Engineer. If the Engineer orders maintenance beyond that required by the Contract Documents for the benefit of the traveling public, the Contractor shall be paid for such maintenance under the respective pay items. The Engineer shall be the sole judge of work to be classed as maintenance beyond that required by the Contract Documents.

D. Rights In and Use of Materials Found on the Work. With the Engineer's or Company representative approval, the Contractor may use on the project such excess stone, gravel, or other material determined suitable by the Engineer or Company representative as may be found in the required excavation. Unless otherwise specified, all other items specified to be removed shall become the property of the Contractor and shall be removed from the site.

E. Final Cleanup. Prior to final acceptance of the project, any borrow and local material sources, and all areas occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, and equipment, and all parts of the work shall be left in as good as or better condition than it was prior to construction, as determined by the Engineer or Company representative.

MEASUREMENT AND PAYMENT

General. Maintenance and protection of traffic shall be bid as a lump sum, and the price bid by the Contractor shall be considered payment in full for the work as follows:

1. Maintenance of roadway and sidewalk areas, as well as detours in the project limits, including sweeping and surface/pothole repairs
2. Storm water control adjacent to roadways, sidewalks, etc.
3. Storm and emergency response to protect the work, including labor, equipment, and materials
4. Relocation services for all traffic control devices, including labor, equipment, vehicles, and supervision costs for installation, moving, damage repair, relocation, and final removal
5. Monitoring of project site on nights, weekends, and holidays
6. Traffic control plan preparation and approval process
7. Notification of police, fire, ambulance, schools, public transit authorities, postal service, neighborhood groups, businesses, etc.
8. Ingress and egress to driveways, bus stops, crosswalks, sidewalks, etc.
9. Maintenance of existing traffic control and street signs
10. Other non-specific or incidental activities not included in other pay items of work associated with traffic control

SITE CLEARING

GENERAL

Description of Work. The work under this Section shall consist of clearing, removing, and disposing of all trees, brush, vegetation, stumps, debris, rubbish, miscellaneous structures not covered under other contract items, and other objectionable matter from within the right-of-way, easement, or construction areas shown on plans, and such other areas as may be specified in the special specifications.

Clearing shall be performed in accordance with the requirements of these specifications. Contractor is required to protect and preserve all items designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor to repair the damage or provide replacement and mitigation in accordance with these specifications and drawings, and to the satisfaction of GCEC or the governing jurisdiction where damage is beyond repair.

Prior to moving onto the project site, the Contractor is required to visit and inspect the site conditions and review the existing plant site and offsite pipeline routes and facilities delineated within GCEC property, easement, and work area boundaries. Prior to any work at the site, the Contractor shall videotape the entire project site, including all lands, all permanent and temporary easements, all access roads, and all other areas impacted by the work. The Contractor shall provide the Engineer or Company Representative with 1 digital copy of the video in the format required by GCEC.

EXECUTION

General. All vegetation and objects designated to remain shall be preserved from injury or defacement. Property and landscape shall be protected and restored per contract requirements.

All materials removed under this Section shall be disposed of within 7 calendar days after cutting, felling, or removal, unless otherwise approved in writing by the Engineer or company representative.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation, and other debris, the Contractor shall comply with the current requirements adopted by the Arizona Department of Health Services pursuant to the authority granted by the Arizona Revised Statutes and as may be amended by local agency requirements. The Contractor shall also comply with any other regulations imposed by the jurisdictional authority.

Clearing. The Engineer or Company representative will establish the limits of areas to be cleared, or areas, objects, or features designated to remain undisturbed. In general, the work areas shall include trenches, structures, detours, and other areas shown on the plans or as specified or directed by the Engineer or Company representative. The Engineer or Company representative will designate structures, debris, rubbish, trees, brush, and vegetation to be cleared. Clearing beyond the limits of construction shall be only where specified or directed.

Removal of cacti and native plants shall be in accordance with the provisions of the Native Plant Law of the Arizona Revised Statutes, Title 3, Chapter 7.

During the life of the contract, the Engineer or Company representative may order the clearing of any trees within the right-of-way or easement that he/she determines to be hazardous or dead and unsightly, and whose condition was a direct result of construction activities.

The Contractor shall carefully prune all branches of trees that have been broken or injured during construction. Scarred surfaces resulting from the work shall be treated with an approved tree paint.

Whenever trees are felled or trimmed on or adjacent to roads, streets, or sidewalks, all wood shall be immediately removed from these areas or any area that would present a hazard to vehicular or pedestrian traffic.

No trees, tree trunks, stumps, or other debris shall be felled, side cast, or placed outside the limits of the right-of-way or easement.

Where trees or existing stumps are cleared, the tree trunk or existing stump shall be cut off not more than 6 inches above the original ground surface unless otherwise approved. Exposed stumps not required to be removed shall be chipped out to a depth of not less than 6 inches below the finished grade. Cavities resulting from the chipping or removal of stumps or trees— unless in areas to be excavated—shall be backfilled with material approved by the Engineer or Company representative within 7 calendar days after removal. The material shall be compacted to a density of not less than 90 percent of the maximum density as determined in accordance with the requirements of Arizona Test Methods 225, 226, 227, 230 or 231, and 232.

Unless otherwise specified in the special specifications, marketable timber and other vegetation not designated to remain shall become the property of the Contractor.

The road right-of-way, easement, and adjacent areas shall be left with a neat and finished appearance. No accumulation of material shall remain on, or adjacent to, the right-of-way or easement.

REMOVAL OF WATER MAINS AND OBSTRUCTIONS

GENERAL

Description of Work. The work under this Section shall consist of the removal— wholly or in part—and satisfactory disposal of all water mains, structures, and obstructions, within rights-of-way or easements, that are necessary in order to complete the items of work in the Contract Documents and are not specifically covered under other items in the Contract Documents.

Existing water mains, pavement, sidewalks, curbs, gutters and other existing improvements that are to become an integral part of the planned improvements shall remain even though not specifically noted.

Non-hazardous materials removed and designated not to be salvaged or incorporated into the work shall become the property of the Contractor, unless otherwise noted.

EXECUTION

General. Except in areas to be excavated, holes, cavities, trenches, and depressions within the construction area resulting from the removal of water mains or obstructions shall be backfilled with suitable material compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of Arizona Test Methods 225, 226, 227, 230 or 231, and 232 or as required by permitting authority, or as directed by the Engineer or Company representative.

Removal of Water Mains.

General.

A. All removed water mains shall become property of the Contractor, unless otherwise noted.

B. Handling and Disposal Procedures for Cement Asbestos Pipe. In addition to the requirements specified herein, the Contractor shall comply with all requirements of the ADEQ pertaining to the handling and disposal of asbestos materials. For information on proper disposal refer to https://www.theasbestosinstitute.com/2020/11/arizona-department-of-environmental-quality-and-asbestos/ .

The Contractor shall be responsible for the proper removal, handling, storage, and disposal of all cement asbestos pipe materials encountered during the course of the work. The Contractor shall comply with all ordinances, laws, procedures, and policies regarding the handling and disposal of cement asbestos pipe as adopted by the jurisdiction in which the work is being conducted, as well as the jurisdiction through whose limits the material must be hauled and/or disposed of. The Contractor shall be responsible for all civil and/or

criminal penalties that may be levied for the improper handling or disposal of the cement asbestos material.

Disposal of cement asbestos pipe material shall occur only at approved asbestos disposal sites.

The Contractor shall direct all questions regarding asbestos disposal to the agency with jurisdiction over the approved disposal site.

The Contractor shall notify the Engineer or Company representative and the approved disposal site a minimum of 24 hours prior to the Contractor's intent to dispose of cement asbestos pipe material. The Contractor shall have obtained and completed all applicable forms and permits prior to disposing of cement asbestos pipe materials.

The Contractor shall provide the Engineer or Company representative with a copy of all executed forms and permits, which shall serve as verification of proper disposal at an approved asbestos disposal site.

Removal of Pavement.

1. **Portland Cement Concrete Pavement**. Unless otherwise specified in the special specifications, concrete pavement designated on the project plans to be removed shall be disposed of by the Contractor at a site secured by him/her. Reinforcement in the broken concrete pavement shall be cut within 3 inches of the concrete pieces.

   The existing pavement to remain shall be saw cut to a true line with straight vertical edges free from irregularities.

2. **Bituminous Pavement**. Unless otherwise specified in the special specifications, all bituminous pavement designated on the plans to be removed shall be disposed of by the Contractor in accordance with the regulations promulgated by ADEQ.

   The existing pavement to remain shall be saw cut to a true line with straight vertical edges free from irregularities.

Removal of Miscellaneous Concrete.

Miscellaneous concrete shall be defined as all or portions of:

- Mortared rubble masonry
- Curbs

- Sidewalks
- Driveways
- Aprons
- Slope paving
- Island paving
- Retaining walls
- Spillways
- Drainage structures
- Concrete box culverts
- Foundations
- Footings
- Manholes
- All other Portland cement concrete or masonry construction except bridges and pavement

All existing miscellaneous concrete shall be removed from the trench area and to a depth of at least 6 inches below the planned invert of the pipe unless otherwise specified in the special specifications or on the project plans, or as approved by the Engineer or Company representative.

When portions of the existing concrete are to remain, the concrete shall be saw cut to a true line with straight vertical edges free from irregularities.

Concrete removal operations shall be performed without damaging any portion to remain in place. All damage to existing concrete that is to remain in place shall be repaired to a condition equal to or better than that existing prior to beginning removal operations. The damaged or broken concrete will be removed to the nearest expansion joint. Repair of existing concrete damaged by the Contractor's operations shall be at his/her expense.

Existing reinforcement to be incorporated in new work shall be protected from damage and shall be thoroughly cleaned of all adhering material before being embedded in new concrete.

Removal of Signs, Delineators, Fire Hydrant Markers, Traffic Signals, and Mailboxes.

Existing warning, regulatory, guide, and route marker signs, delineators, and raised pavement location markers for fire hydrants, traffic signals, and mailboxes that are to be removed shall be reset or replaced by the Contractor in their original location.

The Contractor shall dismantle the sign panels, delineators, and mailboxes, and remove the posts from the ground in such a manner as to prevent damage to the posts. Signs, delineators, and sign posts shall be removed, stored, and reset in accordance with the jurisdictional authority's requirements. Warning and regulatory signs and traffic signals shall be replaced with temporary installations that are in place and functioning prior to removal of the existing signs or traffic signals. Mailboxes shall be reset as temporary installations such that no interruption in delivery service occurs.

Removal or relocation of traffic signals shall be in accordance with the jurisdictional authority.

Removal of Curb. Existing curb designated on the project plans to be removed shall be removed in such a manner as to preserve the existing bituminous or Portland cement concrete surfacing.

The Contractor shall remove existing concrete curb to the nearest expansion joint that will provide for a smooth transition from new to existing curb. If the nearest joint is a scored joint, the Contractor shall saw cut the curb for its full depth and width.

Removal of Fence. All fence to be removed shall become the property of the Contractor, unless designated for salvage on the project plans.

When designated for salvage, fence and gates shall be carefully dismantled and neatly rolled or coiled. Posts shall be cleaned of all concrete and dirt.

In areas where new fence or relocated fence is to be installed, the Contractor shall perform the removals in such a manner as to ensure at all times the security of the area being fenced. All work shall be in accordance with GCEC Fence standard.

Salvaged Items. All listed components shall be excavated and removed with caution and shall remain undamaged during removal and transport. All components shall be delivered to a GCEC facility.

1. 4-inch valves and larger
2. All fire hydrants
3. 4-inch stainless steel or cast PRV and larger

EARTHWORK

GENERAL

Description of Work. The work under this Section shall consist of performing all operations necessary to excavate all materials regardless of character and subsurface conditions from the site or adjacent thereto; to excavate drainage and irrigation ditches and channels; to excavate all materials necessary for the construction of structures; to place backfill for structures, pipe, and other facilities; to backfill holes, pits, and other depressions within the right-of-way or easement; and to remove and replace unsuitable material. All work shall be in conformance with the lines, grades, thicknesses, and typical sections designated on the project plans, specified in the special specifications, directed by the Engineer or Company Representative, and specified herein. Trench excavation and backfill for pipe is detailed in this section.

EXECUTION

General. Operations shall be conducted such that existing roadway facilities, utilities, railroad tracks, and other non-roadway facilities will not be damaged. The Contractor—at his/her expense—shall furnish and install sheet piling, shoring, or whatever materials necessary to adequately support material underlying such facilities, or to support the facilities themselves, and shall maintain such supports until no longer needed. Temporary pavements, facilities, utilities, and installations shall also be protected until no longer required. When temporary supports and other protective means are no longer required, the Contractor shall remove and dispose of them at his/her expense.

When hauling is done over roadways or streets, the loads shall comply with legal load requirements, all material shall be removed from shelf areas of vehicles in order to eliminate spilling of material, and loads shall be watered and covered to eliminate dust. All roadway or streets used for hauling must be returned to original condition prior to final acceptance of the project.

The Contractor shall furnish and apply water for dust control, compaction purposes, and such other purposes as the project requires. The Contractor is also responsible for obtaining the proper water use permit for dust control.

All excavations shall be finished to a smooth and uniform surface, be in reasonably close conformity with the grade established, and in close conformity with the lines, grades, and dimensions shown on the project plans or established by the Engineer.

All suitable material removed from excavated areas may be used instead of construction fill or borrow for backfill of trenches, and in other designated areas if approved by the Engineer or Company Representative.

The Contractor shall provide and maintain earthwork operations to ensure satisfactory surface drainage at all times. Ditches and other drainage facilities necessary to remove ponded water shall be constructed as soon as practical to have the work area dry during progression of work.

All existing culverts and drainage systems shall be maintained in satisfactory operating conditions throughout the course of work. If it is necessary to interrupt existing surface drainage, sewers, culverts, or under-drainage, then temporary drainage facilities shall be provided until permanent drainage work is complete.

INSTALLATION OF WATER LINES

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, tools, and equipment required to install water lines, including pipe, pipe fittings, valves, and all other appurtenances in accordance with the approved plans, these specifications, and the approved materials requirements adopted by GCEC. Where applicable, the Contractor is responsible for obtaining all permits required to complete the work.

Delivery, Storage, and Handling. Pipe ends shall be covered during transportation to prevent exhaust fumes from entering the pipe. Materials delivered to the site of the work in advance of their use shall be stored in a manner minimizing inconvenience to the public. Materials shall be sorted, neatly stored, and easily accessible, and shall be protected from the elements in accordance with the manufacturer's recommendations. Materials that, in the Engineer's or Company Representative's judgment, have been improperly stored or shipped will be rejected for use in the water system.

EXECUTION

General. Operations shall be conducted such that existing roadway facilities, utilities, railroad tracks, and other non-roadway facilities will not be damaged. The Contractor—at his/her expense—shall furnish and install sheet piling, shoring, or whatever materials necessary to adequately support material underlying such facilities or to support the facilities themselves and shall maintain such supports until no longer needed. Temporary pavements, facilities, utilities, and installations shall also be protected until no longer required. When temporary supports and other protective means are no longer required, the Contractor shall remove and dispose of them at his/her expense.

When hauling is done over roadways or streets, the loads shall comply with legal load requirements, all material shall be removed from shelf areas of vehicles in order to eliminate spilling of material, and loads shall be watered or covered to eliminate dust. All roadways or streets used for hauling must be returned to original condition prior to final acceptance of the project.

The Contractor shall furnish and apply water for dust control, compaction purposes, and such other purposes as the project requires. The Contractor is also responsible for obtaining the proper water use permit for dust control.

All suitable material removed from excavated areas may be used instead of construction fill or borrow for backfill of trenches, and in other designated areas if approved by the Engineer or Company Representative.

The Contractor shall provide and maintain earthwork operations to ensure satisfactory surface drainage at all times. Ditches and other drainage facilities necessary to remove ponded water shall be constructed as soon as practical to have the work area dry during progression of work. All existing culverts and drainage systems shall be maintained in satisfactory operating condition throughout the course of work. If it is necessary to interrupt existing surface drainage, sewers, culverts, or under-drainages, then temporary drainage facilities shall be provided until permanent drainage work is complete.

MATERIALS:

All pipes for water lines shall be of the classes shown on the plans or as specified below.

A) The 4-inch through 16-inch diameter pipe sizes may be PVC C900 DR 18 or ductile iron, except where a particular material is specified by the agency or the contract documents. All pipes shall be minimum 150 psi design unless otherwise specified.
B) Pipe 16 inches and larger shall be either ductile iron, or PVC C900 (when approved).

Ductile iron, PVC and cast-iron water pipe and fittings per: C900 PVC per: AWWA C900-07.

Service pipe material shall be approved piping (municipex or equivalent) and shall be installed in accordance with service line installation procedures. Please refer to the installation instructions for pipe handling and care.

Service material containing brass or bronze must comply with the current NSF 61-8 standards at the time the project begins.

All brass or bronze service materials must meet the current AWWA C800 standards.

Any product used in water line construction containing brass or bronze that comes in contact with potable water shall meet the current NSF standards and federal law.

Sequence. The sequence shall conform to the contract time and comply with all required phasing noted on the project plans. The sequence shall also minimize

inconvenience to the traveling public and accommodate the requirements of the jurisdiction within whose rights-of-way the construction is occurring.

Two working days prior to commencement of excavation, the Contractor shall contact Arizona 811 (formerly Arizona Blue Stake) to verify the location of all existing utilities in the work's vicinity.

Laying Pipe: No water main shall be deflected, either vertically or horizontally, in excess of that recommended by the manufacturer of the pipe or coupling.
If adjustment of the position of a length of pipe is required after it has been laid, it shall be removed and rejoined as for a new pipe.

Curb stops with flushing pipes or fire hydrants shall be installed at the ends of dead-end mains according to standard details.

Thrust blocks shall be installed in accordance with this specification.

Valve boxes and covers shall be according to standard details.

DUCTILE IRON WATER PIPE:
All ductile iron water pipe shall be designed in accordance with AWWA C150 and shall be manufactured within the United States in accordance with AWWA C151. The class shall be minimum pressure class or as designated in the plans or special provisions.
Pipe shall be cement mortar lined with a seal coat in accordance with AWWA C104.
Pipe shall be asphaltic seal coated or zinc coated per ISO-8179 with an asphaltic top coat.
Only such packing materials as are included in the list of acceptable materials in AWWA C600 for installation of cast iron water main shall be used. The packing materials shall be handled in such a manner as to avoid contamination and shall be dry when placed in the joints. All such materials shall be free of oil, tar, or greasy substances, except that treated paper packing material, jute, cement, or sulfur compound caulking will not be permitted.

JOINT REQUIREMENTS:
Push-on joints for ductile iron water pipe shall conform to AWWA C111 and shall include synthetic rubber gaskets and lubricant.

Mechanical joints for ductile iron water pipe shall conform to AWWA C111 and shall include cast iron glands, synthetic rubber gaskets, and T-head bolts and nuts.

Flanged joints for ductile iron water pipe shall be as detailed on the plans or as designated in the special provisions.

Restrained Joints: When noted on plans or approved by the Engineer, joints for push-on or mechanical jointed ductile pipe may be modified to provide a fully restrained joint. These modifications to push-on and mechanical joints, including but not limited to segmented or special glands and split sleeves, shall conform to AWWA C111. The Engineer shall review and/or approve each manufacturer's modifications to the joint. Upon request of the Engineer, the manufacturer of the modified joint shall provide test data showing compliance with AWWA C111.

FITTINGS:
Iron fittings shall be either Gray-Iron or Ductile Iron conforming to AWWA C110 or AWWA C153 with a minimum pressure rating of 250 psi. Flanged ends shall conform to AWWA C110. Push-on and mechanical joints ends shall conform to AWWA C111. Fittings shall be cement mortar lined and coal tar coated in accordance with AWWA C104.

PVC C-900 pipe shall be installed in accordance with AWWA C900.

All connections to existing main lines shall be executed by Company Personnel to include main line taps and services. Main line connections will be done with Company Tapping requirements. Main lines 4" and larger shall have a tapping saddle installed, with a resilient seat gate valve, and the tap made with the Mueller CL-12 drilling machine. (Refer to Mueller CL-12 Manual)

Polyethylene Pipe: Polyethylene pipes shall not be kinked, gouged or damaged during installation and backfilling operations. The pipe shall be placed in the trench allowing at least 12 inches per 100 feet for thermal contraction and expansion. Polyethylene pipes have a high thermal expansion and should never be confined under tension. The pipe should not be stored in the sun or left in the trench under abnormally high temperature. The pipe shall be carefully snaked in the trench bottom and covered up with uniform slack throughout its length. In trenches less than 8 inches in width, the expansion shall be obtained by making the tap on the opposite side of the main from the water meter and providing a loop of slack service pipe back over the top of the water main. Before installing, inspect pipe to detect any damage that may be caused by shipping, storage or handling. Damage spots can be cut out and pipe recoupled with Ford C-44, C-66, or approved equal brass compression fitting to form a continuous length. Damaged pipes shall not be used. Polyethylene pipes shall

be cut only with a tubing cutter with rollers properly designated for the size of pipe being cut. When polyethylene pipe is used, the meter box setting must be placed parallel to the back of the sidewalk in accordance with standard details. Polyethylene pipes shall be installed with large sweeping bends with radius of not less than 18 inches. Polyethylene pipes have a cold flow characteristic and must not be installed under stressed conditions. Compression fittings only may be used with the plastic being held securely between metal to metal. Stainless steel or brass inserts shall be placed in the proper position in each compression fitting with care taken to ensure that the insert remains in place when the fitting is tightened. All meter service lines shall be extended at right angles from the main to the curb lines.

Service Taps: ¾ inch through 2-inch service taps to new meter mains may be made with a saddle according to provisions below:
The developer may use saddles on all sizes of pipe when approved by GCEC. Bronze corporation stops must be installed in the saddles prior to pressure testing or disinfection of the water main. In subdivisions, saddles are required for 6-inch pipe and larger. At GCEC's option, saddles may be used on all 6-inch pipe and larger. All service connections on major and collector streets shall be made with saddles regardless of the water main size or service pipe size. All taps on pipe smaller than 6 inches must be made by a saddle. All wet taps must be made with a Company-approved tapping machine. A sharp tapping bit must be used in order to obtain clean sharp threads. In general, each tapping tool should be resharpened or discarded after making six taps. The minimum distance between saddles shall be 18 inches.

SERVICE OVER 2 INCHES:
All service taps larger than 2 inches shall be made by the Company after an application and payment of prevailing fees, unless otherwise required by the Company.

SERVICE ON EXISTING MAINS:
Where all or part of a new subdivision is served by existing water mains, only authorized personnel of the Company shall install the service connections upon proper application and payment of prevailing fees.

HYDROSTATIC PRESSURE TESTING OF WATER FACILITIES

Testing and Chlorination. After the installation of all pipes, specified fittings, valves, hydrants, service lines, temporary highlines, and thrust restraints, the following procedure shall be followed to provide a basis of acceptance of all new work:

(A) **Preliminary Flushing.** Mains, hydrants, and appurtenances shall be flushed at a mean main velocity of at least 2.5 feet per second for a period of 60 seconds per 100-foot length of the section of the work being flushed. In areas where the existing system will not produce the required mean velocity, the maximum mean velocity shall be achieved for a commensurately longer duration as directed by the Engineer. All flushing water, both preliminary and final, shall be recovered for compactive or dust palliative purposes, directed to adequate surface drainage courses, or disposed of by directing it into adjacent trench backfill. In no instances shall flushing waters be allowed to pond or pool so as to cause hazards or nuisances to adjacent properties or the public.

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required to hydrostatically test water facilities in accordance with the requirements of these specifications. The Contractor shall provide a calibrated pump suction tank for the test pressure pump. Water line to be tested shall pass a pretest conducted by the Contractor before the official test is scheduled.

TESTING:
All services, service taps and fittings shall be tested along with the water main.

EXECUTION

General. All new water line installations—including services, and fire hydrants—shall be subjected to a hydrostatic pressure test. In the event the new water line requires connection to an existing line to fill the new line with water, the connection between the existing and new lines shall be broken and the new line plugged prior to commencing the test, unless prior approval is received from the Engineer.

Hydrostatic pressure testing of all water lines shall be conducted with potable water only. Air testing is not allowed.

The Contractor (or company if they are testing the main) shall furnish all material, equipment, and labor necessary to perform the hydrostatic pressure test with the exception of the pressure gauge, which shall be provided by the Engineer. These components shall be considered incidental to the construction and testing of the water line.

Hydrostatic pressure testing shall be conducted upon completion of backfill and installation of thrust restraints.

Hydrostatic testing shall **not** be conducted against existing valves unless written approval is issued by the Engineer or Company Representative. However, it is understood by the Contractor that such acceptance shall in no way relieve the Contractor of responsibility for damage to lines, valves, or appurtenances caused by the test. Furthermore, the Company assumes no risk, liability, or obligation of any kind regarding the condition of existing facilities or any connection the Contractor may make to said facilities. Any damage to new or existing water facilities resulting from hydrostatic testing shall be repaired at the Contractor's sole cost.

All sections of newly installed water line shall be inspected to ensure all entrapped air has been completely expelled from the pipe, valves, and hydrants. If permanent air-release outlets are not located at all high points, the Contractor shall install additional air-release ports as may be necessary or as directed by the Engineer or Company Representative. Air release valves are for air removal only, and shall not be installed until after the pipeline has been tested, or new ball valves shall be closed to isolate the air release valves during test;

The test pump may be either hand or motor driven, and shall be connected to the water line under test only through a tap into the main.

Workmanship. All personnel employed by the Contractor or his/her subcontractors shall be skilled and knowledgeable regarding the installation procedures for the pipe, fittings, and appurtenances being installed.

Traffic Control. The Contractor shall comply with the requirements of the traffic control section of the standard.

Water Shutoffs and Recharging. Should construction require shutoff of the water system, the Contractor shall coordinate with the Inspector or Company Representative **a minimum of 14 days** prior to the planned system shutoff. The Contractor may be required to operate the necessary valves under the Inspector's or Company Representative's direction. When operating valves under the Inspector's or Company Representative's direction, the Contractor assumes no liability for damage to the valves during normal operation.

The Contractor shall be responsible for notifying all affected water users of the time and duration of the system shutoff. Notification shall be by information card delivered not less than 24 hours prior to the scheduled shutoff. The shutoff notification cards will be supplied by GCEC, with the area to be notified determined by GCEC Personnel or Company Representative. The information card shall provide a phone number at which the Contractor can be reached 24 hours a day for water users' questions and inquiries. Shutoff shall not be made during operating hours to any lines serving customers dependent on water services, unless other arrangements have been approved by the Engineer or Company Representative. Work involving these customers may be required at night or on weekends. Upon request, the Engineer or Company Representative will provide the Contractor with valve and service maps of the existing water system.

If Contractor must make an emergency turnoff because of broken pipelines, he/she must contact the Office or On Call Personnel at 1(928) 485-2451 and request a shutdown of the area affected.

Hydrostatic Testing. Hydrostatic testing shall be conducted only after all new work has been installed and only in the Engineer's or Company Representative presence. The hydrostatic test pressures specified herein shall be maintained for a period of 2 hours.

Unless otherwise noted in the special specifications, on the plans, or as directed by the Engineer, test pressures shall conform to the following requirements.

Table 0210-1
Minimum Hydrostatic Test Pressure Requirements

Pipe	Minimum Test Pressure
DIP (Includes all Components)	200 psi
PVC (Includes all Components)	200 psi

Acceptance shall be determined on the basis of zero allowable leakage. Should any test of installed pipe disclose leakage measured by a drop in pressure, the Contractor shall—at no additional cost to the Company—locate and make repairs approved and inspected by the Engineer or Company Representative, until there is no drop in pressure for the minimum 2-hour test. Retesting of segments shall be with the identical test boundaries used for the initial test. The Contractor shall repair all visible leaks, regardless of the amount of leakage.

DISINFECTING WATER MAINS:

Isolation: Unless otherwise directed by GCEC, new water mains shall be physically isolated from active distribution systems until initial disinfection and satisfactory bacteriological results have been completed. The means for protecting active distribution systems from contamination due to reverse flow shall be according to the level of protection required by Arizona Administrative Code (A.A.C) R18-4-215. Physical breaks or gaps in the water main line are acceptable; or temporary insertion of a properly sized and certified reduced pressure backflow assembly ("jumper" set-up) is also an acceptable method. Check with GCEC for specific requirements.

Disinfection: The method of chlorination used shall be approved by GCEC and must conform to NSF/ANSI 60 & 61 and the AWWA C651 latest-version standards or ADEQ Engineering Bulletin 8. GCEC shall determine the number and locations for sample risers. The Contractor is responsible for supplying equipment to properly dose the new main with a chlorine concentration not less than 50 parts per million (ppm). GCEC or its authorized representative will verify the chlorine level is at 50 ppm at time of dosing and verify that after 24 hours of high chlorine solution sitting in the pipes that the chlorine concentration is at 10 ppm or greater. All new valves, hydrants and other appurtenances shall be operated fully to ensure full disinfection from the chlorine solution.
After 24-hour verification is complete, the water main shall be completely flushed of the high chlorine concentration. A chlorine neutralizing agent may be required during flushing discharge. Confirm discharge and neutralization requirements with GCEC before flushing.

1) **Methods of Applying Chlorine:** One of the following methods of application of chlorine shall be used, subject to approval by GCEC.
    a. Liquid chlorine gas-water mixture.
    b. Calcium or sodium hypochlorite and water mixture.
2) **Point of Application:** The preferred point of application of the chlorinating agent is at the beginning of the pipeline extension or any valved section of it and through a corporation stop inserted in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap or other potable water source on the pressure side of the gate valve controlling the flow into the pipeline extension.

    If using a potable water tank mounted on a vehicle or trailer to fill the new pipe the following shall apply: Vehicles hauling water for drinking or potable uses must be operated with a permit. In order to qualify for a permit, the vehicle must be inspected and must comply with all regulations listed in Title 18, Chapter 4, Section 214 of the Arizona Administrative Code. Furthermore, a chlorine residual shall be obtained at the source used to fill the tank and taken again before the tank is emptied. A log must be kept of the chlorine residuals. A method approved by GCEC shall be used for verifying chlorine

residuals. Minimal chlorine residuals shall not be less than 0.20 parts per million (ppm) (equivalent to 0.2 mg/l).

3) Rate of Application: Water from the existing distribution system or other approved potable water source of supply shall be controlled so the rate of flow shall not exceed 500 gpm, unless approved by GCEC, through a suitable measuring device into the newly laid pipeline during the application of chlorine. The rate of chlorine solution flow shall be in such proportion to the rate of water entering the pipe that the chlorine dose applied to the water entering the newly laid pipe shall produce at least 10 ppm of residual chlorine after 24 hours standing in the pipe. This may be expected with an application of 50 ppm, although some conditions may require more.

   On lines 12 inches in diameter or less, determination of the rate of flow of water into the line to be treated may be made by starting with the line full of water and measuring the rate of discharge at a hydrant located at the end of the pipe farthest away from the point of chlorine application. For lines larger than 12 inches in diameter, the disinfection operation is generally started with the line empty.

4) Retention Period: The highly chlorinated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. This period should be at least 24 hours and no more than 48 hours.
   If the circumstances are such that less than a 24-hour retention period must be used and upon approval by GCEC, the chlorine concentration shall be increased to 100 ppm not to exceed 300 ppm and retained for at least 2 hours. Under these conditions, special care should be taken to avoid chemical attack on pipes, valves, hydrants and other appurtenances.

5) Short Pipe Sections/Laterals/Stubs: For short sections of new pipelines of up to twenty feet or less in length and where the new line cannot be isolated for testing or installation of a temporary backflow and metering set-up is not possible or feasible, the following procedure may be used with GCEC approval on a case-by-case basis. Various modifications may be necessary or required depending on specific circumstances. This does not apply to small diameter domestic copper water services of up to two inches.
   a. 100% of all new pipe materials/fittings used in the installation and tie-in from the existing main line to the backflow assembly on fire lines and up to the first meter, connection on domestic water lines shall be disinfected. Any new tie-in valves at the main line shall remain completely closed.
   b. All new pipe materials/fittings used in the installation and tie-in are to be disinfected by swabbing with a chlorine solution of at least 200 ppm using NSF/ANSI 60 & 61 approved equipment, materials and chemicals. GCEC or its authorized representative shall verify that the chlorine solution meets the strength requirements. Inspector shall witness the swabbing procedure and document results. A new swabbing device should be used for each new line.

c. The new lines and fittings shall remain empty and closed to the atmosphere for 24 hours to allow the high chlorine treatment sufficient time to disinfect.
d. After the 24-hour period, with GCEC supervision, the new valves shall be operated, and the ends of the lines shall be opened at the largest port available to allow initial flushing of the high chlorine solution. GCEC or its authorized representative shall test this first flow of water to verify that at least 10 ppm of chlorine is still present. The line can then continue to be sufficiently flushed until the chlorine levels are below 2.0 ppm as verified by GCEC.
e. The new lateral valves at the main tie-in shall then be closed and remain closed after flushing; the new lateral line shall remain charged with water and allowed to sit for an additional 24 hours.
f. After 24 hours, GCEC or its authorized representative shall check the chlorine residual levels and collect microbiological samples for lab testing as detailed herein.
g. The new lateral valves at the main tie-in shall remain closed until GCEC receives the laboratory results that show a negative or "Absent" reading for both Total Coliform and E. coli.

Final Flushing, Sampling and Testing: Following chlorination, all treated water in the newly laid pipeline shall be thoroughly flushed until the replacement water throughout the new pipeline can be proved, by laboratory testing, comparable in quality to the water served to the public from the existing water system. Prior to sampling for laboratory testing, the residual chlorine throughout the length of the pipeline shall be reduced to 2.0 ppm or less as approved by GCEC and consistent with ADEQ Engineering Bulletin 8. Once the required residual chlorine level in the pipeline is achieved, bacteriological samples shall be taken as outlined below.

GCEC or its authorized representative shall collect all samples for testing of the new water mains. To initiate the sampling and testing, the Contractor will present to GCEC or its authorized representative a written request for such work no later than 48 hours prior to the time when samples are to be taken. Samples shall be taken from a tap and riser located and installed in such a way as to prevent outside contamination. Samples shall never be taken from an unsterilized hose or from fire hydrants.

The number and types of sampling locations shall be per the flushing plan as approved or determined by GCEC or its authorized representative; and at a minimum, shall be as follows:

- Waterlines up to but less than 150 feet in length require one sampling riser installed as near the end as possible
- Waterlines 150 feet to 300 feet in length, two sampling risers, one near each end of the line.
- Waterlines 300 feet to 2,640 feet in length, a minimum of three sampling risers. In addition, dead ends on main lines should be represented with a sampling riser.

- Waterlines greater than 2,640 feet in length shall require a minimum of one additional sampling riser per 1,000 feet.

The Contractor shall install the correct type of sampling risers at the locations shown on the approved flushing plan; or as otherwise directed by GCEC or its authorized representative. Sampling risers must be at least 18 inches above grade and no more than 48 inches above grade. Sampling risers can be attached to service line curb stops, line blow-off outlets, tapped end-of-line caps, permanent industrial sampling stations or sampling specific taps (saddle, corp stop & riser). Sampling risers shall be made of rigid NSF/ANSI 60 & 61 approved piping material for potable water. The sampling riser outlet must be able to adjust the flow of water and shall not contain inside or outside threads. The sampling riser outlet shall be pointed downward perpendicular to the ground.

The specific method or combination of methods, sequencing, number of required samples at each sampling location and minimum wait times shall be determined by GCEC or its authorized representative. GCEC may require two sample sets and may require or allow different wait times before samples can be taken. For two sample sets, allow 15 minutes between sampling times. The standard sampling methods are listed as follows:

(A) One sample (or set of samples) from each sampling location taken 24 hours after flushing high chlorine and no water use is examined in the laboratory using the Total Coliform (TC) method.
(B) Two samples taken on separate days from each sampling location. An additional sample (or set of samples) is taken after an additional 24 hours, and no water use is examined in the laboratory using the Total Coliform (TC) method.
(C) Standard heterotrophic plate count (HPC) test. Samples shall be taken at the same location, and time, as the Total Coliform samples. At a minimum, each HPC test result must be reported as less than 500 CFU/ml or at a limit established by the Contracting Agency.

Upon completion of laboratory testing, results of all tests shall be sent by the designated laboratory to GCEC. Results of laboratory analysis will be interpreted by GCEC and reported back to the Contractor. Under no circumstances shall the Contractor contact the laboratory. If there is a need to obtain test results before the actual written reports are submitted, such information shall be obtained only from GCEC. All reported test results must show a negative or "Absent" reading for both Total Coliform and E. coli.

If any sample in the initial treatment fails to pass the Total Coliform or HPC tests, all sample locations shall be resampled and retested at the Contractor's expense using the duplicate disinfection procedures listed above and shall be repeated until satisfactory results are obtained.

Final Connections: Any temporary air release blow-offs and test sampling risers shall be left exposed, accessible and protected during backfill operations until all testing is complete. After

all testing has been completed and passed acceptance, all temporary blow-offs and sampling risers shall be properly lowered and terminated as directed by GCEC.

Connections to existing pipelines or existing valves shall not be made until all new pipe main lines or specific sections thereof satisfactorily passed all required hydrostatic and disinfection tests and GCEC gives approval to make the final connections and put new water mainline into service.

PIPE MARKING, DETECTION TAPE, AND TRACER WIRE

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment necessary for providing and installing pipe-marking tape, pipe-detection tape, and tracer wire in accordance with the requirements of these specifications and the approved materials requirements adopted by GCEC.

Delivery, Storage, and Handling. Pipe-marking tape, pipe-detection tape, and tracer wire shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer or Company Representative.

Pipe-marking tape, pipe-detection tape, and tracer wire shall be stored in a manner such that it is protected from prolonged exposure to sunlight and/or extreme heat.

EXECUTION

(A) **General.** Potable water detectable pipe-locating tape shall be installed after the trench is backfilled to within 18 inches of finished grade. The Contractor shall install detectable pipe-locating tape over all water mains in accordance with GCEC-approved standard details.

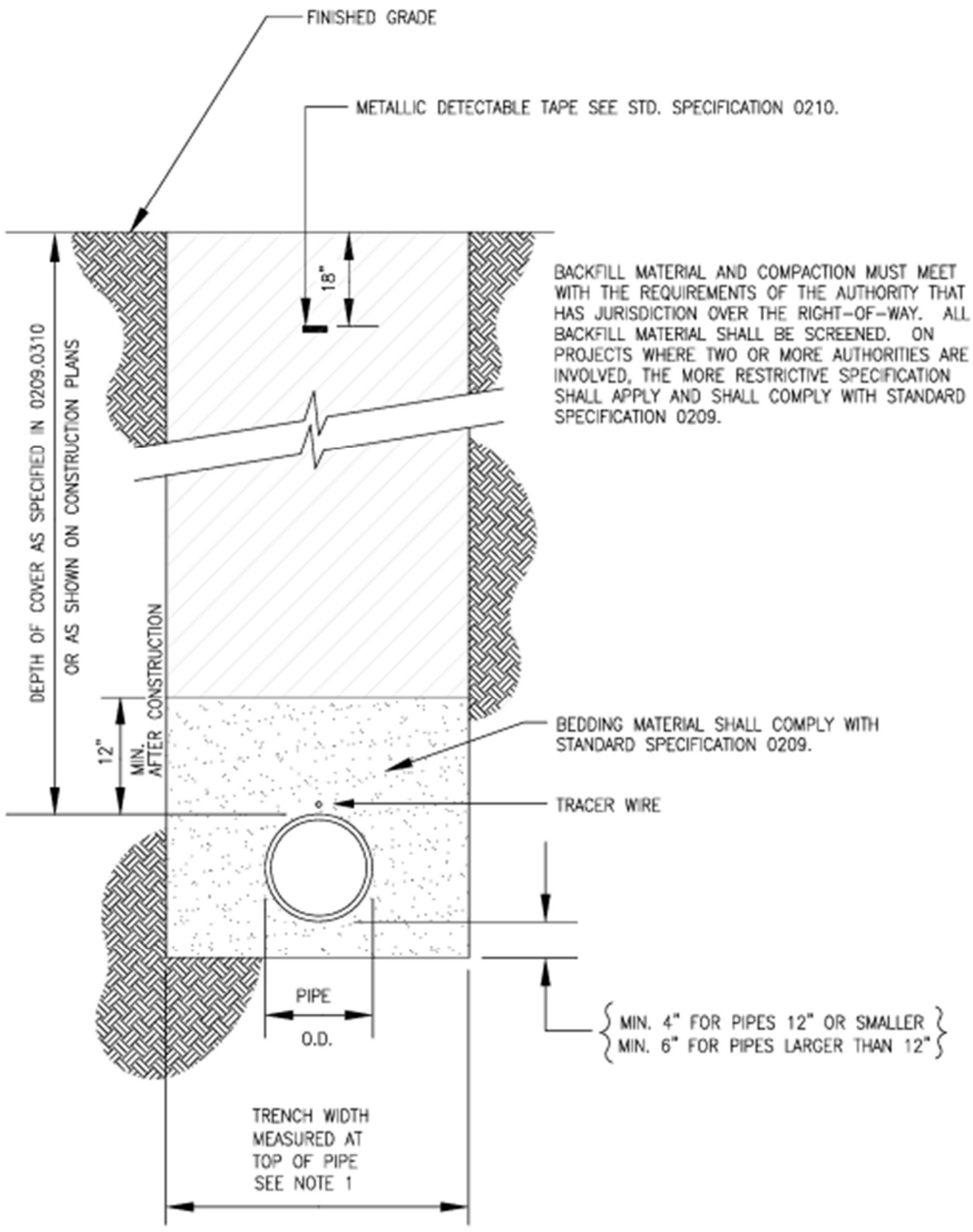
The remainder of the trench shall then be backfilled in accordance with the applicable standards and special specifications.

The tape shall consist of inert polyethylene plastic no less than 4.0 mils thick and impervious to alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil, with a metallic foil core at least 1/3 mil thick. The tape shall be at least 2 inches in width and solid blue in color with identifying print in black letters.

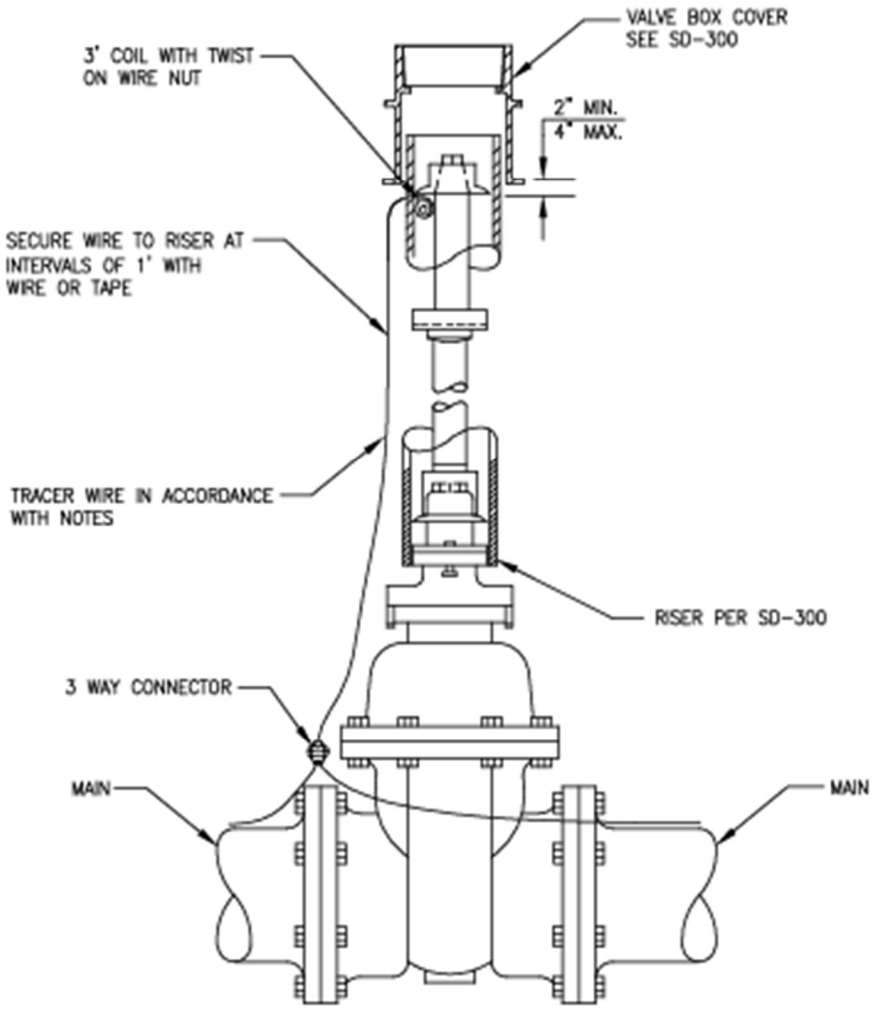
"CAUTION — BURIED WATER LINE BELOW"

Identifying lettering shall at least 1 inch high and repeated continuously the full length of the tape. In no instance shall the spacing of the identifying message's individual segment exceed 8 inches.

(B) **Tracer Wire**. All water lines and appurtenances require the installation of tracer wire. 14 gauge tracer wire shall be laid directly on top of the pipe along the pipe centerline and shall be permanently affixed by wrapping the pipe circumference with 10-mil PVC pipe tape. The tracer wire is to be certified by the Company Representative.



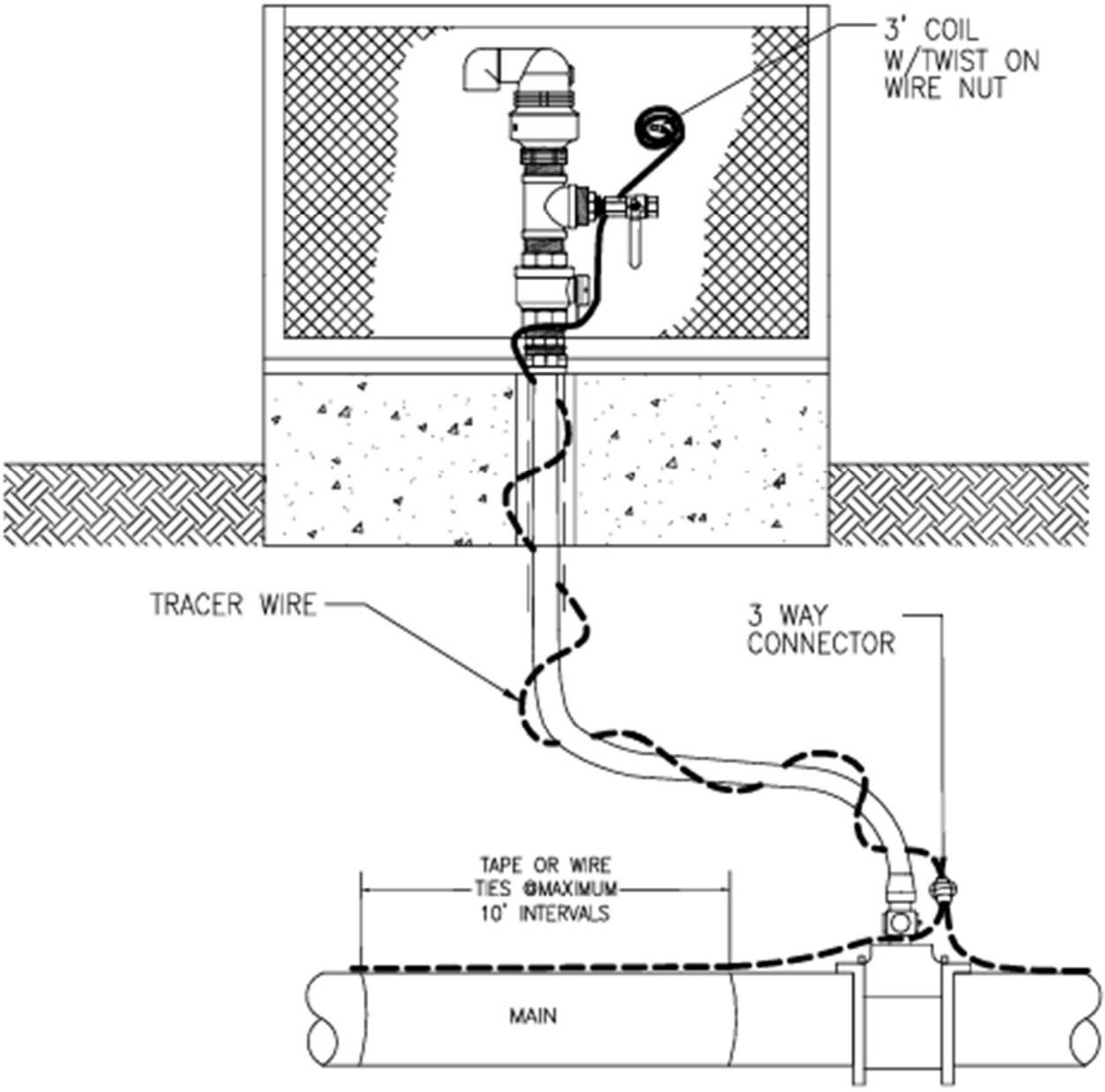
1. TRENCH WIDTH MEASURED AT THE TOP OF THE PIPE SHALL BE 18" FOR 4" AND 6" MAINS AND 24" FOR 8" MAINS. TRENCH WIDTH FOR 12" AND LARGER SHALL BE O.D. + 18" MIN., O.D. + 24" MAX, OR PER OSHA REQUIREMENTS.
2. BEDDING MATERIAL SHALL BE ACTUAL TRENCH WIDTH (BANK TO BANK)
3. PAVEMENT PATCHING SHALL CONFORM WITH THE REQUIREMENTS OF THE PIMA ASSOCIATION OF GOVERNMENTS



CONNECTION TO IN-LINE VALVES

NOTES:

1. TRACER WIRE SHALL BE SECURED TO THE RISER AT MAXIMUM INTERVALS OF 1'.
2. THREAD TRACER WIRE THROUGH ¼" HOLE DRILLED IN THE RISER PIPE 2" TO 4" BELOW THE VALVE BOX. A KNOT SHALL BE TIED IN THE TRACER WIRE INSIDE THE RISER PIPE AND A 3' COIL OF WIRE LEFT NEATLY INSIDE THE RISER.
3. A TWIST ON WIRENUT SHALL BE INSTALLED ON END OF TRACER WIRE INSIDE OF RISER.



AIR RELEASE VALVE

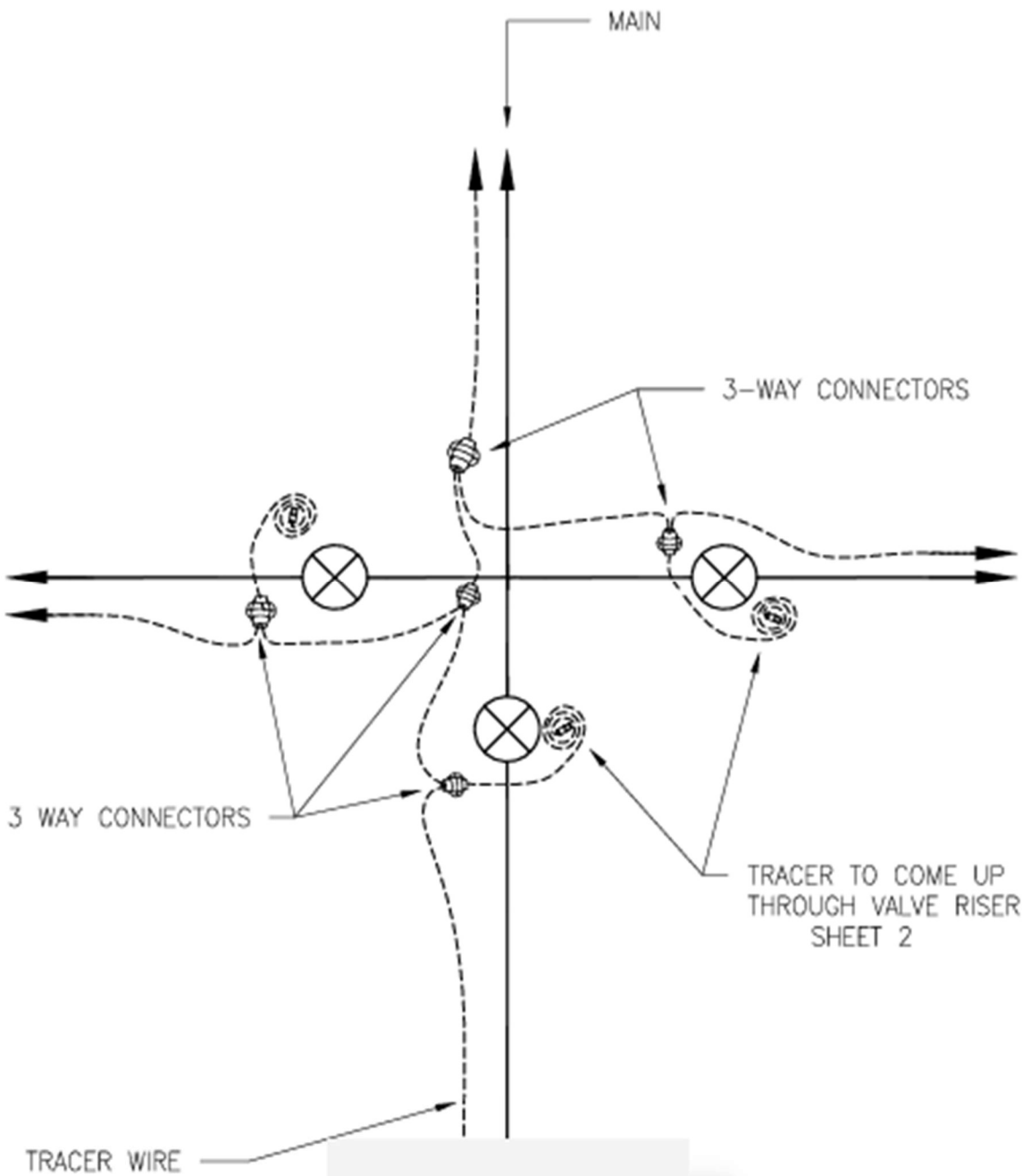
NOT TO SCALE

NOTES:

1. THE TRACER WIRE SHALL BE ATTACHED TO THE AIR RELEASE LINE WITH TAPE AT 1' INTERVALS. A 3' COIL OF WIRE SHALL BE LEFT IN THE METER BOX

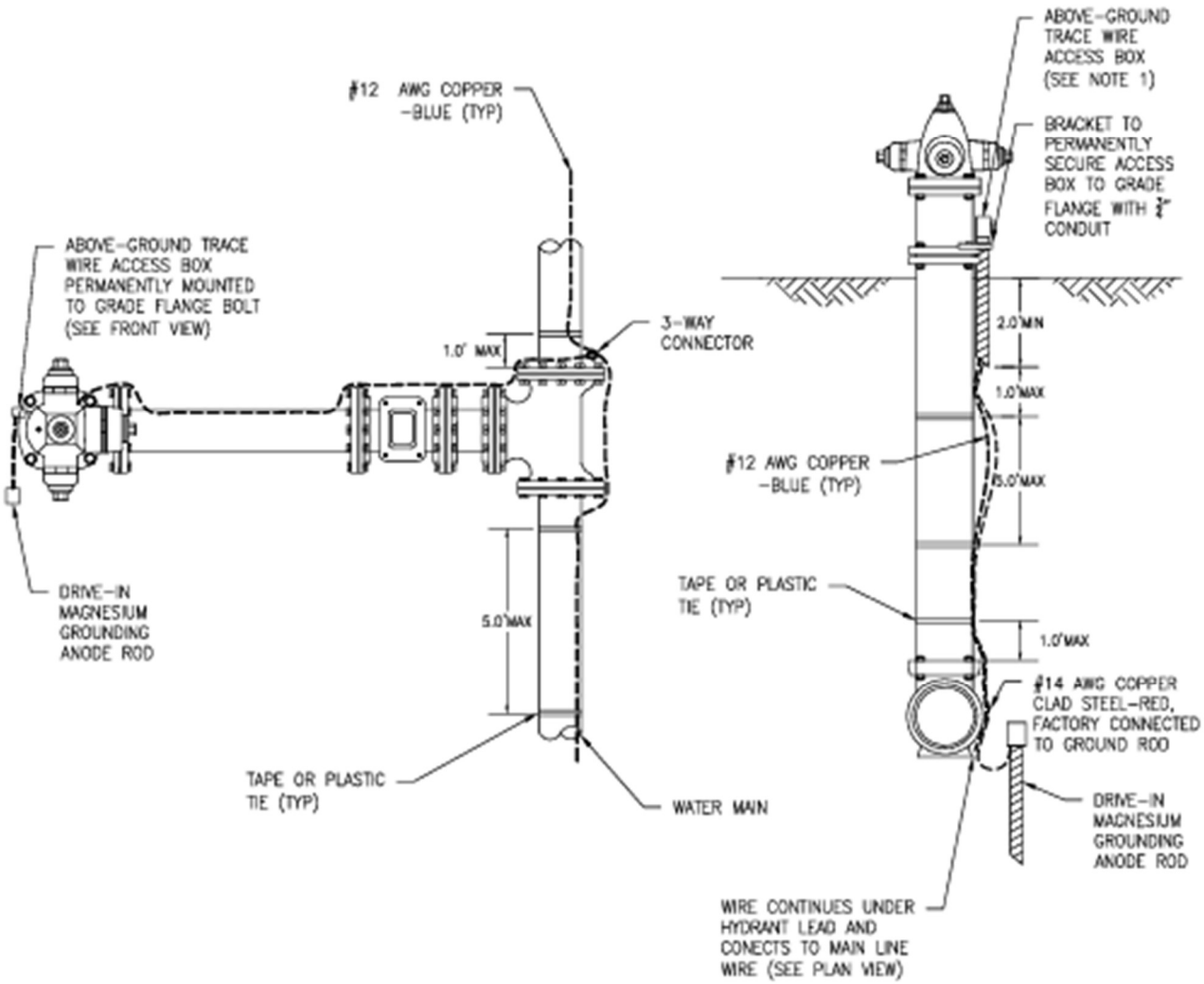
2. THIS DETAIL APPLIES TO AIR RELEASE VALVES IN SD-330 AND SD-331.

EXAMPLE OF 4-WAY CROSS USING 3-WAY CONNECTORS



AA

Caps Lock On

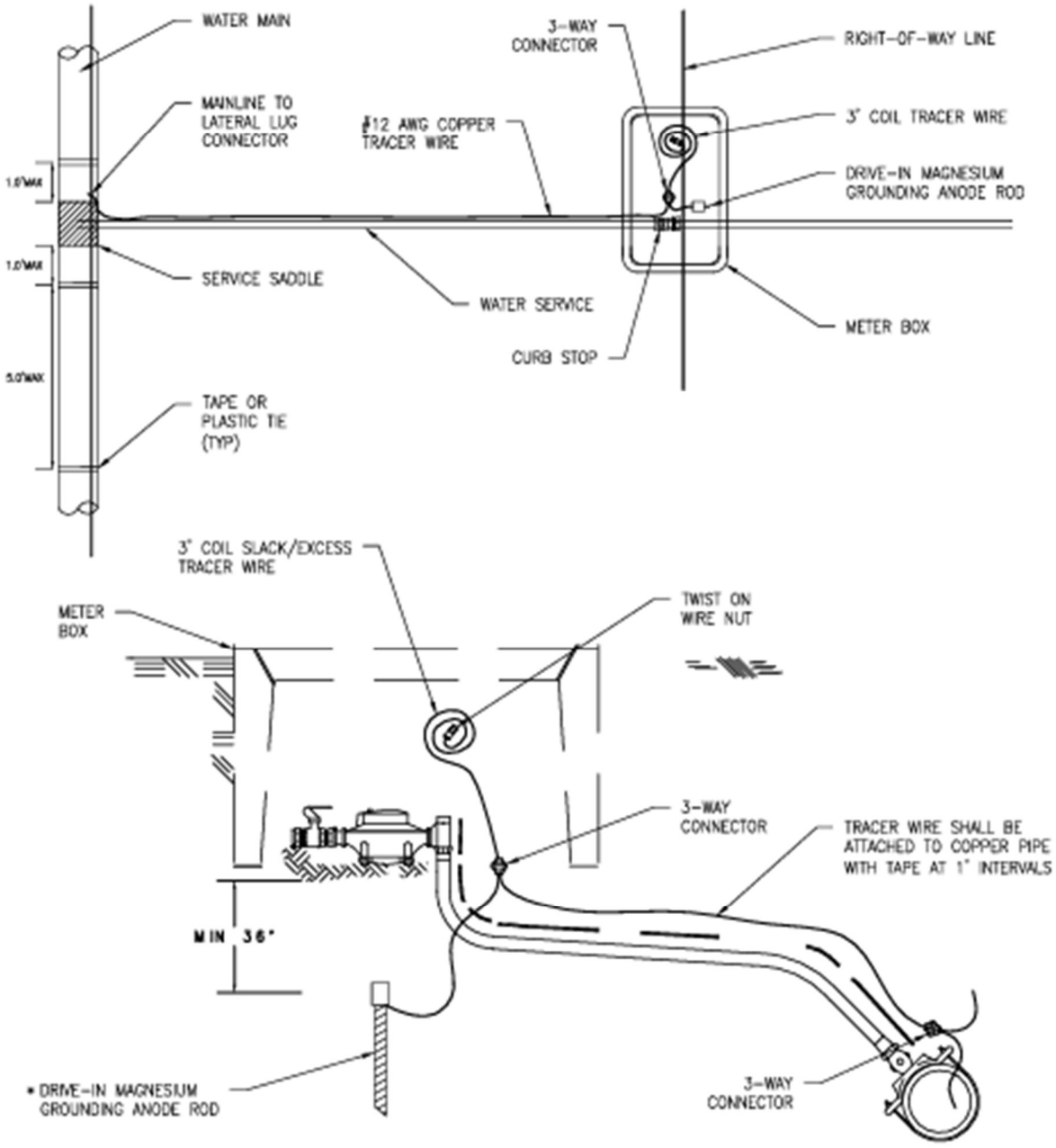


HYDRANT – PLAN VIEW
NO SCALE

HYDRANT – SECTION VIEW
NO SCALE

NOTES:

1. TRACER WIRE BOX SHALL NOT BE INSTALLED BELOW PUMPER NOZZLE OF HOSE NOZZLE, BOX SHALL BE INSTALLED AT THE BACKSIDE OF THE FIRE HYDRANT. ALL OUTLETS MUST HAVE SUFFICIENT CLEARANCE TO OPEN WITHOUT AFFECTING THE TRACER WIRE BOX. MINIMUM 2' OF ¾" CONDUIT SHALL BE INSTALLED TO ACCESS BOX.



*NOTE:

WATER SERVICE ANODES ARE NOT REQUIRED WHERE METERS ARE LOCATED WITHIN 150FT FROM EACH OTHER IN SUBDIVISIONS WITH MULTIPLE RESIDENTIAL LOTS.

TRENCH EXCAVATION, BACKFILLING AND COMPACTION

DESCRIPTION:

The work covered by this specification consists of furnishing all labor, equipment, appliances, materials, and performing all operations in connection with the excavation, backfilling and compaction of trenches for pipe installations.

Excavation for appurtenance structures, such as manholes, inlets, transition structures, junction structures, vaults, valve boxes, etc., shall be deemed to be in the category of trench excavation.

The trench shall be excavated to the minimum width called for the proper bedding and laying of pipe. The trench shall be excavated to a depth necessary to comply with the requirements shown on the plans and standard specifications, as well as these special provisions.

All trench banks shall be as nearly vertical as practical and shall be braced by shoring or sheeting as required to protect the excavation and adjacent utilities, and to safeguard employees from cave-ins or falling rocks. The Contractor is responsible for complying with all applicable OSHA regulations.

Pipe and pipe appurtenances shall be carefully lowered into the trench by means of slings, pipe tongs, or other acceptable means. Water line materials shall not be dropped or dumped into the trench. Care shall be taken to avoid damage to the pipe coating or lining.

Pipe materials that are considered to be rigid include steel casings, cast iron, and ductile iron pipe.

Pipe materials that are considered to be flexible include thermoplastic pipes (HDPE, SRPE, PP, PVC), and corrugated metal pipe.

EXCAVATION:

General: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the plans, and including excavation ordered by the Engineer of compacted backfill for the purpose of making density tests on any portion of the backfill.

Trench Widths: Trenches for a single pipe shall conform to the dimensions in the Table below. Multiple pipe installations in a single trench shall be installed in accordance with details on the plans or in the special provisions.
Trench Excavation.

TRENCH WIDTHS		
Size of Pipe (Nom. Dia.)	**Maximum Width at Top of Pipe Greater Than O.D. of Bell**	**Minimum Width at Springline Each Side of Pipe Barrel**
Rigid Pipes:		
Less than 18 inches	16 inches	6 inches
18 inches to 24 inches inclusive	19 inches	7.5 inches
Flexible Pipes:		
Less than 18 inches	20 inches	8 inches
18 inches to 24 inches inclusive	23 inches	9.5 inches

The width of the trench shall not be greater than the maximum indicated in above table, at and below the level of the top of the pipe. The width of the trench above that level may be made as wide as necessary for shoring, bracing, and for proper installation of the work

If the maximum trench width specified in the table is exceeded at the top of pipe, additional load-bearing capacity may be required by the Engineer at no additional cost to GCEC. Where safety or undermining conditions occur, controlled low-strength material may be used when approved by the Engineer and consistent with the applicable CLSM requirements of these standards.

Trench Grade: Alignment and elevation stakes shall be furnished by the Contractor at set intervals and agreed upon offsets. On water main projects, elevation stakes will be furnished only when deemed necessary by the Engineer. In all cases where elevation stakes are furnished, the Contractor will also furnish the Engineer with cut sheets.

For all pipe 12 inches or greater in diameter, the Contractor shall excavate for and provide a bedding at least 4 inches thick or 1/12 the O.D. of the pipe barrel whichever

is greater. This bedding material shall be placed at a uniform density with minimum compaction and fine graded as specified herein.

Fine Grading: The bedding or the bottom of the trench when bedding is not required shall be accurately graded to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for portions of the pipe where it is necessary to excavate for bells or other joint types and for proper sealing of the pipe joints

Over-excavation: Except at locations where excavation of rock from the bottom of the trench is required, care shall be taken not to excavate below the depth needed to accommodate the required bedding depth. Where the foundation material is loosened or otherwise disturbed more than 2 inches deep, the Contractor shall moisten and recompact the material before placing bedding.

Unauthorized excavation below the specified trench grade line shall be refilled at the Contractor's expense with ABC material compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTO T-99 and T-191 or ASTM D6938. When AASHTO T-99, method A or B, and T-191 are used for density determination, AASHTO T99 Annex A will be used for rock correction. Whenever rock is encountered in the trench bottom, it shall be over-excavated to a minimum depth of six inches below the bottom of the pipe barrel. This over-excavation shall be filled with bedding material placed with the minimum possible compaction.

Whenever unsuitable soil incapable of supporting the pipe is encountered, the Contractor will notify the Engineer and a field determination will be made as to the depth of over-excavation and the granular fill required.

Trench excavation shall consist of furnishing all labor, materials, and equipment required for cutting, removal and disposal of pavement, trench excavation, and trench backfill. Backfill material and compaction shall be in accordance with the requirements of the authority that has jurisdiction over the right-of-way. On projects where 2 or more authorities are involved, the more restrictive specification shall apply.

(A) **Trenches**.

a. **Longitudinal Trenches.** For excavation parallel to the centerline, on roadways classified as major streets, or as otherwise required by the Engineer, the length of open trench shall not exceed 200 feet or the distance between the centerlines of adjacent cross streets, whichever is less.

   For excavations occurring on minor streets or alleys, the length of open trench may be 450 feet or the length of pipe installed in one day, whichever is less. In no case, however, shall two adjacent cross streets be closed to traffic at the same time.

   Should it become impossible to maintain access to private property, the property owner/occupant shall be given written notice a minimum of 48 hours prior to the closure of access. Access shall be restored at the end of each work day.

b. **Transverse Trenches.** For excavations transverse to the centerline on roadways classified as major streets, trench lengths shall not exceed one-half the roadway width, unless otherwise authorized by the permitting jurisdiction. Emergency vehicle passage shall be maintained at all times.

   In roadways containing median dividers, traffic will be maintained on both sides of the median, unless otherwise authorized by the permitting jurisdiction.

   Minor through streets and alleys may be closed when authorized by the permitting jurisdiction. Installations in streets with a single outlet must maintain emergency vehicle access at all times.

c. **Excavated Material.** Material excavated from the trench may be windrowed along the side of the trench in such a location that no collapsing soil loads are transmitted to the trench walls, and no hazard to traffic—motorist or pedestrian—is created. Excavated material shall not, in any manner, inhibit access to, or the use of, fire hydrants, driveways, or mailboxes.

(B) **Unsuitable Material.** Unsuitable material below the natural ground surface in fill areas, and below the finished elevation in excavation areas, shall be excavated and disposed of as directed by the Engineer or Company Representative
When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use.

(C) **Surplus Material.** Unless otherwise indicated on the project plans or specified in the special specifications, surplus excavated material shall be removed from the

job site and disposed of by the Contractor in a manner approved by the Engineer or Company Representative and in accordance with the requirements found in the General Provisions of the standard contract conditions.

Shortages of material caused by the Contractor's disposal of any material before fill quantities are satisfied shall be replaced at the Contractor's expense.

(D) Trench Safety

1. **Shoring and Sheeting.** When trench shoring and/or sheeting is installed as necessary due to space limitations or for trench safety and/or the protection of existing adjacent above- or underground facilities, the shoring and/or sheeting shall comply with current OSHA regulations.
2. **Dewatering.** Water tables shall be kept below final trench grade. Trenches shall be kept free of water for the period of time beginning prior to excavation and ending when the trench backfill is above the water table that existed prior to construction. The Contractor shall construct and maintain the necessary facilities—such as pumps, wells, drains, dams, and channels—to keep the trench free of water. If pumps are used, a minimum of one standby pump shall be on the job site. If well points are used, the Contractor must obtain the necessary dewatering permit from the Arizona Department of Water Resources.

   Water removed from the site shall be conducted to drainage facilities without causing damage or disturbance to adjacent property. The Contractor shall be responsible for, and shall repair at his/her expense, any damage caused by water or protective works. Water levels shall be changed slowly and uniformly so as to not impair the stability of slopes and soil properties. No direct payment shall be made for dewatering unless otherwise specified in the special specifications.
3. **Obstructions.** Should existing pipe, conduit culverts, duct banks, or other structures or obstructions not noted on the plans be encountered in the excavation and be in conflict with the proposed pipe alignment, the Engineer may approve additional excavation or direct relocation of a portion of the trench to alleviate the condition. Payment for additional excavation and backfill resulting from these changes shall be made in accordance with the provisions of the General Provisions of the standard contract conditions. Additional payment shall not be made in cases where vertical or horizontal alignment changes are made by the Contractor for his/her convenience.

Bedding Material.

(A) **Bedding Material Using Pipe Shade**.

1. **Material.** Pipe bedding material shall meet the following sieve analysis and plasticity requirements:

Table 0209-1
Bedding Material Requirements

Normal Size	Percent Passing
1 inch	100
No. 4	60-100
No. 200	0-10

The plasticity index shall not exceed 5 when tested in accordance with the AASHTO T 90.

Bedding shall be certified by an independent testing facility when delivered to the project site or by stockpile, as directed by the Company Representative. Material the Company Representative deems unsuitable must be recertified. All certifications are the Contractor's responsibility and are of no expense to GCEC Water.

GCEC Water reserves the right to adjust these pipe bedding requirements on an individual basis to meet unexpected field/soil conditions.

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the area into which bedding material is to be placed.

2. **Placement.** Pipe with an inside diameter of 12 inches or less shall be installed on a minimum 4-inch thickness of bedding material. Pipe with a diameter greater than 12 inches shall be installed on a minimum 6-inch thickness of bedding material. Bedding thickness shall be measured after installation of pipe.

Bedding material shall be placed in uniform horizontal layers not exceeding 12 inches in depth before compaction. For pipe 24 inches in diameter or larger, lift thickness shall be determined by method of compaction and approved by the Engineer.

Bedding material shall be placed under, around, and over the pipe to an elevation 1 foot above the top of the pipe after compaction.

Bedding material shall be placed in a manner that will prevent distortion, damage to, or displacement of the pipe from its intended location. Bedding material shall also be placed so that adequate support will be provided in the haunch areas of the pipe. Voids or loose soils found to occur due to improper placement or compaction of bedding materials will result in rejection of that portion of the pipe installation. Replacement of the pipe will be at the Contractor's expense.

Bedding material shall be compacted to at least 90 percent of the maximum density determined in accordance with the requirements of Arizona Test Methods 225, 226 , 227, 230 or 231, and 232.

(B) Bedding Material Using Controlled Low Strength Material (CLSM).

1. **Material.** The Contractor shall proportion the CLSM to be homogenous, flowable, non-segregating, self-consolidating low-shrink slurry. Materials and proportions used shall meet the requirements of these specifications.
    a. **Design Strength.** The unconfined compressive strength at 7 days shall be a minimum of 80 pounds per square inch and a maximum of 300 pounds per square inch. The Contractor shall form test cylinders with proposed materials to confirm design strength and mix design in accordance with ASTM D1633. Final mix approval and use of the material shall not occur prior to confirmation for strength by the cylinder breaks.
    b. **Mix Design.** The Contractor and his/her suppliers shall determine the materials and proportions used to meet the requirements of these specifications. The CLSM mix shall be modified as necessary to meet the flowability, pumpability, and set time requirements for each individual pour.

        No CLSM shall be placed until the Engineer has issued written approval of the mix design. The Engineer's approval of the mix design shall be understood to indicate conditional acceptance. Final acceptance will be based on tests conducted on field samples and conformance with these specifications

2. **Placement.** Requirements are as follows:
    a. The pipe shall be supported above the trench floor on pea gravel bags or sandbag supports as shown on the plans.
    b. Following placement of the pipe, any unstable soil at the top of the trench that might fall into the trench during placement of the CLSM shall be removed.

c. The Contractor shall deliver the CLSM to the trench in ready-mix trucks and utilize pumps or chutes to place the CLSM in the trench. CLSM shall be directed to one side of the pipe, with care taken not to displace the pipe at any time. The Contractor shall continue placing CLSM on side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1 foot above the pipe bottom. Handheld vibrators shall be used to continuously liquefy and move CLSM into all voids. Water in mixture shall be adjusted to maintain fluid consistency while also maintaining strength requirements. The Contractor shall continue placing CLSM on both sides of the pipe, continuously using the vibrators for every 30 feet of pipe run.
d. Pipe and conduit stability shall be maintained throughout CLSM placement and curing. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the Contractor shall conform with these Contract Documents at no additional cost to the Agency. All sloughed material or other debris from top of previously placed CLSM shall be removed.
e. CLSM shall be allowed to cure a minimum of 4 hours prior to placing each lift or trench zone material. The Engineer may approve a shorter cure period if it can be demonstrated to the Engineer that the CLSM will support the individual lift or trench zone material.
f. The Contractor shall resume backfilling operations using the techniques described above to complete the pipe zone backfill. Engineer must approve the pipe zone backfill prior to initiating the trench zone backfill.

Installation.

A) **General.** Pipe shall be installed in conformance with the requirements specified herein and AWWA installations standards. Pipe shall be transported, unloaded, stored at the job site, and handled in a manner so as to prevent damage to the pipe. During transportation and storage, the pipe ends shall be securely covered. Any pipe section that, upon inspection, has been damaged shall be replaced by the Contractor at no additional cost to the GCEC. Should the damage be such that the pipe can be repaired, the Contractor shall undertake repairs, to the Engineer's or Company Representative's satisfaction, at the Contractor's sole expense.

The trench shall be excavated to the minimum width called for the proper bedding and laying of pipe. The trench shall be excavated to a depth necessary to comply with the requirements shown on the plans and standard specifications, as well as these special provisions. All trench banks shall be as nearly vertical as practical and shall be braced by shoring or sheeting as required to protect the excavation and adjacent

utilities, and to safeguard employees from cave-ins or falling rocks. The Contractor is responsible for complying with all applicable OSHA regulations.

Pipe and pipe appurtenances shall be carefully lowered into the trench by means of slings, pipe tongs, or other acceptable means. Water line materials shall not be dropped or dumped into the trench. Care shall be taken to avoid damage to the pipe coating or lining.

Water mains shall be installed with a minimum 48 inches of cover from finished grade. Where the roadway or right-of-way is n ot at final grade, cover shall be measured from future finished grade shown on the approved construction drawings. **Cover-depth hierarchy.** The minimum standard cover for water mains is 48 inches from finished grade; temporary construction cover shall not be less than 36 inches; and reduced cover below 48 inches is permitted only when a written engineered exception is approved by GCEC and all required protection is installed.

During construction, water mains shall maintain not less than 36 inches of temporary cover unless otherwise approved in writing by the Engineer and protected as directed by GCEC.

Tracer wire shall be installed on all new pipe shown on the drawings. All costs associated with the installation of tracer wire shall be included in the unit price bid per linear foot of new transmission and distribution mains and services.

B) **Laying Pipe.** All pipe, pipe fittings, valves, and other appurtenances shall be carefully examined for damage or other defects immediately prior to installation. Defective materials shall be legibly marked. The Contractor may initiate repairs upon the Engineer's or Company Representative's approval. However, should the Engineer or Company Representative determine that repairs will not satisfactorily correct the damage or defect, the material in question shall be replaced, in kind, at the Contractor's expense.

During laying operations, no debris, tools, clothing, or other items shall be placed in the pipe.

Pipe shall be laid in reasonably close conformity with lines, grades, and dimensions shown on the project plans or as directed by the Engineer.

Pipe shall not be laid in water or when trench conditions are unsuitable for the work, as determined by the Engineer or Company Representative. When work is not in

progress, open ends of pipe, fittings, and valves shall be securely plugged to eliminate water, earth, or other foreign material from entering the opening. Plugs shall be utility test plugs or as approved by the Engineer or Company Representative.

Pipe that has had the grade or joint disturbed after laying shall be removed and inspected by the Engineer or Company Representative to determine if it may be reused.

During pipe laying and backfill operations, water mains shall maintain not less than 36 inches of temporary cover unless otherwise approved in writing by the Engineer and protected as directed by GCEC.

1. **Ductile Iron Pipe.** Installation of ductile iron pipe shall conform to the applicable requirements of AWWA C600, AWWA M41 and the requirements of this Section. Joint assembly, including maximum joint deflection, shall conform to Section 3.4 of AWWA C600.

   All ductile iron pipe—including valves and fittings—shall be encased in polyethylene in accordance with ANSI A21.599 (AWWA C105) Type A. The Contractor shall clean the pipe of all clay, mud, or other foreign material prior to installation of the polyethylene encasement. During installation, the Contractor shall take care to prevent trapping soil or bedding material between the pipe and polyethylene encasement.

   The Contractor shall fit the polyethylene encasement to the contour of the pipe to effect a snug—but not tight—encasement with minimum space between the polyethylene and the pipe. Sufficient slack shall be provided in contouring to prevent stretching the polyethylene when bridging irregular surfaces—such as bell-spigot interfaces, bolted joints, or fittings—and to prevent damage to the polyethylene during backfilling operations. Overlaps and ends shall be secured with polyethylene-compatible adhesive tape or any other material capable of holding the polyethylene in place until backfilling operations are complete.

2. **Polyvinyl Chloride Pipe.** Installation of polyvinyl chloride (PVC) pipe shall conform to the requirements of AWWA C900, AWWA C905 and AWWA M23, except as may be modified herein.
   PVC pipe bell and spigot joints shall be assembled/installed with no horizontal or vertical joint deflection and no longitudinal pipe bending. The Contractor shall use standard approved bends/fittings or a manufacturer's specifically designed gasketed joint to achieve pipe deflection. If a project requires a curved pipe

alignment and fittings cannot be used to accommodate the installation of PVC, ductile iron pipe may be used. Standard ductile iron pipe joints (4 to 12 inches) are designed to accommodate up to 5 degrees in deflection.

Cutting of Pipe. PVC pipe shall be cut in a neat and workmanlike manner without damage to the pipe. Pipe ends shall be cut square, deburred, and beveled in accordance with the manufacturer's recommendations.

Cutting of ductile iron pipe shall conform to the requirements of Section 3.4 of AWWA C600.

Connections. All material and equipment required to make a connection or tie-in shall be on the job site prior to commencement of this work. When required, equipment will include a pump with hoses.

The Company shall thoroughly flush existing dead-end mains prior to making the tie-in.

All existing water lines to be abandoned in place shall be cut and plugged. Cost of cutting and plugging shall be included in the cost per foot of the new pipe.

Thrust Restraint. Thrust restraint shall conform to the requirements of this standard.

Service Connections. Unless otherwise approved in writing by the Engineer, service connections and taps shall be made prior to hydrostatic testing.

Backfilling. Backfilling for purposes of this specification shall consist of filling the trench void from 1 foot above the top of pipe to the elevation of the lower limit of the pavement patch or other surface treatment, if not under pavement. The Contractor shall exercise due caution to prevent damage or collapse of pipe or appurtenances in the pipe zone.

Final backfill shall provide the minimum 48 inches of cover from finished grade required for water mains, unless a written engineered exception is approved by GCEC.

Trench backfill within the roadway of any jurisdiction shall conform to the requirements for imported material as noted herein, or as required by the jurisdictional authority, whichever is more restrictive. Unless otherwise specified in the special specifications, the top 6 inches of the finished surface shall be compacted to a density of not less than 95 percent of the maximum of dry density as determined in accordance with the requirements of Arizona Test Methods 225, 226, 227, 230 or 231, and 232. However, the required density shall be 100 percent of the maximum density when asphaltic concrete or Portland cement concrete is to be placed directly on the finished surface.

Backfill shall be placed in uniform loose layers not exceeding 8 inches in depth before compaction, unless otherwise approved by the Engineer or Company Representative.

Backfill material shall be compacted to the following percentages of the maximum dry density determined in accordance with the Arizona Test Methods 225, 226, and 232:

Table 0209-2
Compaction of Backfill Material

Location	Maximum Dry Density (Percentage)
Within roadways or streets that are paved or scheduled to be paved during the next 12 months.	**95**
Within street rights-of-ways and public easements for roadway prism of unpaved streets, alleys and parkways that may be scheduled to vehicular traffic and not scheduled to be paved during the next 12 months.	**95**
Alleys, easements, parkways, and areas outside the roadway	**95**

(A) Materials.

1. **Native Material.** Native material is material excavated from the trench. Native material used for trench backfill shall be free from deleterious and organic substances, chunks of clay, concrete, asphaltic concrete, asphaltic concrete millings, and debris of any nature. Prior to use as backfill material, native material shall be screened of stone larger than 6 inches in greatest dimension. No native material will be allowed for use as bedding unless approved by Company Representative. Asphalt in any form shall not be used in any water line trench.

2. **Imported Material.** Imported material used for trench backfill shall conform to the following gradation:

Table 0209-3
Imported Material Requirements

Sieve Size	Percent Passing
6 inch	100

¾ inch	60-100
No. 8	35-80
No. 200	0-12

The plasticity index shall not exceed 12 when tested in accordance with the requirements of AASHTO T 90.

Imported material used for trench backfill shall be free from deleterious and organic substances, chunks of clay, concrete, asphaltic concrete, asphaltic concrete millings, ground glass, and debris of any nature. Prior to use as backfill material, native material shall be screened of stone larger than 6 inches in greatest dimension. No native material will be allowed for use as bedding. Asphalt in any form shall not be used in any water line trench.

As an alternative to the material requirements of imported material, the Engineer may allow a slurry mixture meeting the requirements specified by the Engineer.

(B) **Surface Restoration and Cleanup.** Any damage done to public or private property as a result of the Contractor's operations shall be restored by the Contractor at his/her expense to a condition as good as, or better than, that existing prior to construction.

(C) **Utility Locations and Separations.** Utility locations are shown on the plans for design purposes only. In general, the locations of major utilities, both above- and underground, are indicated on the drawings. This information has been obtained from utility maps, field survey work, and descriptions provided by the various agencies involved, and represents the best information available. GCEC does not guarantee the accuracy or completeness of this information, and it is to be understood that other facilities not shown on the drawings may be encountered during the course of the work.

Under State Law (Arizona Revised Statues, Title 40, Chapter 2, Article 6.3—Underground Facilities), the Contractor is required to contact all utilities in order to determine the location of existing utilities within the limits of his/her work. The Contractor is responsible for making any necessary repair to utilities damaged by his/her operation, at his/her own expense.

Water main construction shall conform to the following separation requirements with regard to other existing utility lines:

(1) Electric/Gas. Water mains shall not be installed within a 2-foot horizontal distance of parallel electric cables, conduits, or gas lines. The minimum vertical separation between electric cables, conduits, gas lines, and the water main at any location shall be 12 inches. Water services and fire hydrants shall not be installed at the same

property corners as electrical pedestals or transformers, and shall be separated by a minimum horizontal distance of 10 feet.

When electric, telephone, cable, fiber optic, or gas facilities parallel water facilities, they shall not be installed with less than 2 feet of horizontal clearance from the water main unless the system has been approved for joint-use trench. If joint-use trench is approved, the joint-use trench detail must be shown on the approved plans.

High-pressure gas transmissions shall have vertical/horizontal separations notated on the plans or approved by the owners of each utility. Corrosion control may be necessary for installation of the water line.

(2) **Storm Drain Culvert.** The minimum vertical separation between the water main and storm drain culvert shall be 36 inches when the water main cannot be installed above the storm drain culvert. If minimum cover cannot be achieved when installing water mains over a storm drain culvert, the Contractor—with the Engineer's approval—may install the water main with less than the minimum cover under the following conditions:

   a. The water main material shall be ductile iron, in accordance with GCEC Specifications.
   b. Separation between the water main and the top of the storm drain culvert shall be no less than 12 inches. Under no circumstances shall the water line have less than 24 inches of cover unless a written engineered exception is approved by GCEC.

(3) **Sanitary Sewer.** Water mains installed in the vicinity of sanitary sewer mains shall comply with applicable Arizona regulatory requirements, the governing wastewater agency requirements, and GCEC-approved standard details. Where requirements conflict, the more restrictive requirement shall apply unless otherwise approved in writing by the Engineer.

NOTES:

1. Where a water main crosses above a gravity sewer with a 2' or greater vertical clearance (outside surface to outside surface), no extra protection is required. Where a water main crosses above a pressure sewer with 6' or greater vertical clearance, no extra protection is required.

2. Where a water main must cross above a gravity sewer with less than 2' of clearance, construct or replace the sewer line with ductile iron pipe (D.I.P.) or approved equal. The D.I.P. must have a "push-on" joint or approved equal if the sewer joints are located 6' or more beyond the outside surface of the water main. If a joint is located less than 6' from the outside surface of the water main, then a restrained joint or approved equal shall be used. See the plan views on sheet 3 for reference. In no case shall the water main be less than 1' above a gravity sewer or 2' above a pressure sewer.

3. Where a water main crosses below either a gravity sewer or a pressure sewer, construct or replace the sewer line with D.I.P. or approved equal following the guidelines given in Note No. 2. In no case shall the water main be less than 2' below either a gravity or pressure sewer line.

4. The minimum horizontal clearance without extra protection between a water main and a pressure or gravity sewer line shall be 6' outside surface to outside surface.

5. The minimum horizontal clearance between a water main and a sewer manhole shall be 6' from the outside surface of the water main to the centerline of the manhole.

6. Where a 6' horizontal clearance cannot be maintained with a gravity sewer, construct or replace the sewer line with D.I.P. or approved equal following the guidelines given in Note No. 2. In no case shall a gravity sewer line be located less than 2' horizontally from a water main.

7. In no case shall a pressure sewer line be located less than 6' horizontally from a water main.

8. The American National Standard for the thickness design of Ductile Iron Pipe (ANSI/AWWA C150/A21.50) shall be used to determine the required class of D.I.P. except that for D.I.P. with a diameter of 3" through 24", a minimum of Class 350 is required and for D.I.P. with a diameter greater than 24", a minimum of Class 200 is required.

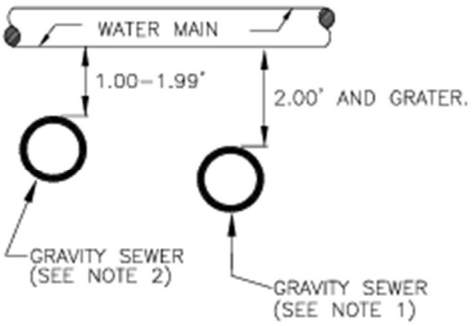
9. Where the sewer line is a gravity sewer, the D.I.P. installation of replacement pipe shall extend a minimum of 6' beyond each side of the water main, measured horizontally from and perpendicular to the water main.

10. Where the sewer line is a pressure sewer, the D.I.P. installation of replacement pipe shall extend a minimum of 10' beyond each side of the water main, measured horizontally from and perpendicular to the water main.

11. In general, when unusual conditions such as, but not limited to, highway or bridge crossings prevent the water and sewer line separations required by this detail from being met, the Pima County Regional Wastewater Reclamation Department will review and may approve (subject to Arizona Department of Environmental Quality's approval), requests for authorization to use alternate construction techniques and joints on a case-by-case basis.

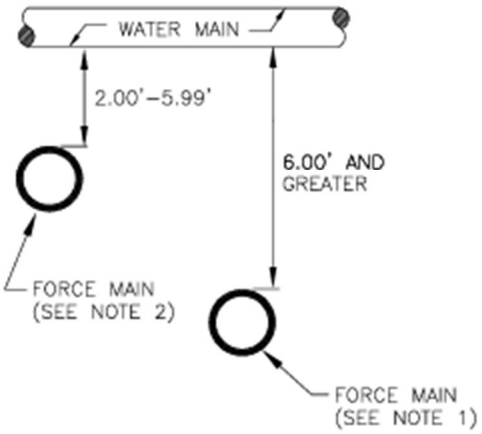
12. All Ductile Iron Pipe shall be internally lined to meet the most recent Pima County Regional Wastewater Reclamation Department specifications.

VERTICAL SEPARATION



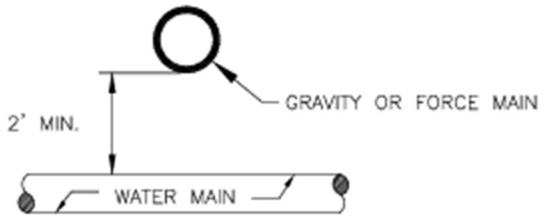
GRAVITY SEWER CROSSING

(SEWER UNDER WATER MAIN)



FORCE MAIN CROSSING

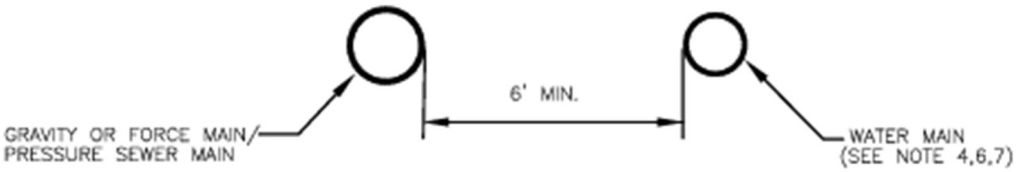
(SEWER UNDER WATER MAIN)



GRAVITY OR FORCE MAIN CROSSING

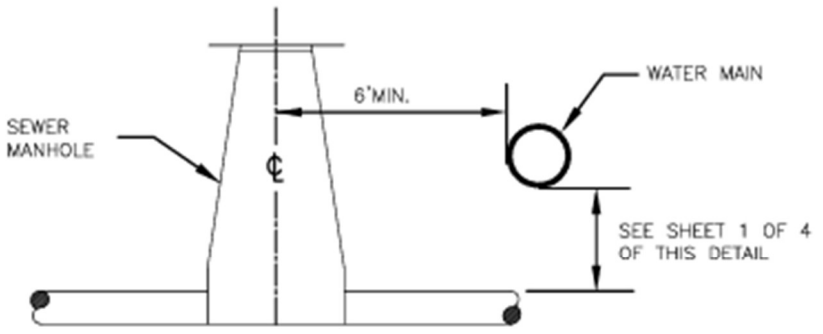
(SEWER ABOVE WATER MAIN)

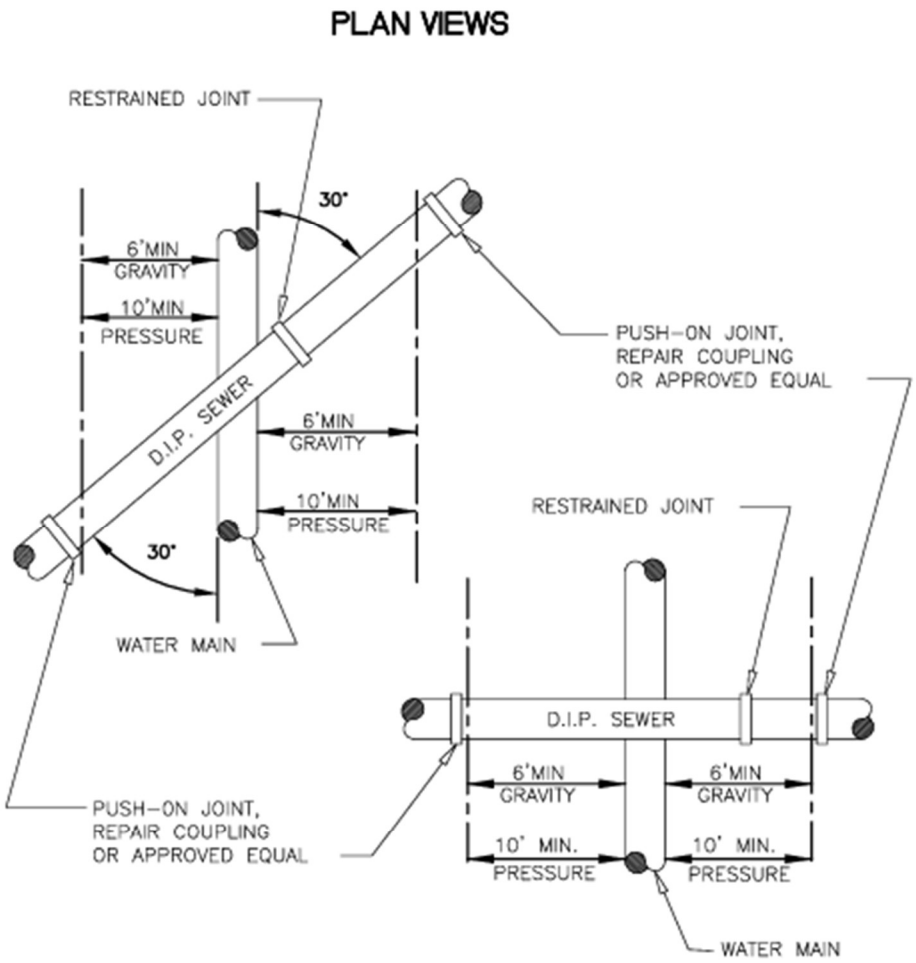
HORIZONTAL SEPARATION



SEWER / WATER SEPARATION

(PARALELL ALIGNMENTS)





Temporary Highline. If a highline is required, the Contractor shall construct the highline per Engineer drawings. All pipe and components shall be NSF 61 for potable water. All tie-overs to the highline will need a GCEC employee for valve isolation. The Contractor shall be responsible for protection of the highline and must make any necessary repairs to the highline to maintain service at all times while the highline is in use.

PAVEMENT REPLACEMENT

GENERAL

Description of Work. The work under this Section shall consist of furnishing and installing pavement replacement. Installation of pavement replacement shall be in accordance with the plans and the requirements of these specifications.

PRODUCTS

Materials. All pavement replacement construction shall conform to the approved plans, these specifications, and the requirements of the jurisdiction responsible for the right-of-way. The following materials and specifications shall apply:

EXECUTION

Class P Concrete General. Pavement, ditches, driveways, and roadways disturbed or damaged by the Contractor's operations not directly associated with pipeline installation shall be replaced or restored by the Contractor to as good condition as they were previous to the commencement of the work at no additional cost to the Owner. All pavement that is cut or removed shall be replaced according to the following specifications:

Removal of Asphaltic or Concrete Pavement. Pavement removal for the pipeline will include all asphaltic or concrete pavement, plus subbase material, within the limits specified. Existing pavement shall be power-saw cut to provide a clean edge for new pavement. Wheel cutting is not permitted. Pavement removed prior to trenching shall be a width of at least 12 inches past each side of the proposed trench. Transverse crossing of paved streets requires replacement of twice the trench width for the pipeline and pipeline appurtenances. Damaged pavement outside the pavement cut width limits shall be saw cut in perpendicular cuts and shall also be removed and replaced by Contractor at his/her expense. Pavement removal for transverse crossing will include all asphaltic or concrete pavement, plus subbase material. Where temporary patching is required, pavement removal to the full specified width shall be deferred until the temporary patch is removed.

T**emporary Paving Patch.** Contractor shall place a 2-inch thickness of temporary cold mix patch pavement immediately after backfilling trenches in paved roadways. During progress of the entire work, the Contractor shall maintain in good and safe condition the surface of the paved area over the trench and shall promptly fill all depressions over and adjacent to the trench caused

by settlement of backfill. Final surface shall be of uniform texture, conforming to the existing pavement grades.

Temporary Paving Patch Removal. The temporary paving patch shall be removed from the trench, and the trench shall be excavated to provide for the permanent pavement replacement. Any over-excavation shall be brought to grade with aggregate base course. If it has not already been accomplished in the backfill, the subgrade is then to be wetted to optimum moisture content and compacted to 95 percent of standard density as determined by test designation ASTSM D698, Method A. The existing paving edge shall receive a tack coat of liquid asphalt before the new pavement is laid in contact with it.

Replacement of Asphaltic Pavement. All asphaltic pavement replaced in the public right-of-way.

For longitudinal trenches with top widths that exceed 4 feet, the roadway shall be repaved with a combination of materials having the same structural strength and surface course as the existing pavement (with a minimum of 2-inch AC over 6-inch ABC) according to the following schedule:

TABLE

Pavement Replacement

Trench With at Top	Repaving Width
4 -12 Feet	One-half pavement width or one lane width, depending on trench location
Over 12 Feet	Full Pavement Width

Patches for transverse trench shall be twice the trench width.

Removal of Loose Cover Aggregate. Contractor shall remove all loose cover aggregate from the finished pavement patch before traffic has dispersed the loose chips throughout. This work is to be done before final acceptance of the job.

Pavement Striping. Pavement striping shall be as required by Graham County. At a minimum, Contractor shall provide “in kind” striping after removal of loose material.

EXISTING VEGETATION AND NATIVE PLANTS

GENERAL

Description of Work. The work under this Section shall consist of protecting and transplanting native plants as required in the project-specific Native Plant Mitigation Plan. Relocation of native plants and irrigation shall be in accordance with the plans and the requirements of these specifications.

PRODUCTS

Materials. The Contractor shall ensure that all relocated or transplanted native plants are in a sound, healthy condition, free from insect infestations, bark abrasions, weak branches, or other objectionable disfigurements, and shall immediately replace any unacceptable plants. All native plants are to be warranted for a maintenance period of 1 year from final acceptance of the project. During the maintenance period, all native plants are to be guaranteed to remain in a healthy, vigorous state of growth. At any time up to and including the end of the maintenance period, native plants found unacceptable to the Engineer will be replaced, and the replacement native plants will be guaranteed for an additional 1 year.

To ensure the survivability of all native plants installed—whether transplanted or newly purchased vegetation—the Contractor shall provide the services of a licensed landscape contractor for monthly landscape and irrigation maintenance during the maintenance period.

A detailed revegetation and mitigation plan shall be submitted to the Engineer for review at least 15 days prior to the start of revegetation work.

EXECUTION

General. The Contractor shall provide the services of a licensed landscape contractor for Native Plant Preservation revegetation and mitigation work within the right-of-way or easements and comply with the requirements in the project's Native Plant Preservation Plan.

Revegetation work shall include transplanting existing native vegetation, and furnishing and planting native plants as required. In addition, this work shall include the tagging of native vegetation and the installation, maintenance, and removal of construction fencing to protect native plants to be preserved in place.

Prior to bidding this project, the Contractor shall obtain a copy of the Native Plant Law—Arizona Revised Statutes, Title 3, Chapter 7—and familiarize himself/herself with said requirements for preservation of native plants affected by this project.

The Contractor shall obtain and comply with the proper permits from the Arizona State Department of Agriculture and Horticulture prior to the removal or relocation of any protected plants as defined in the Arizona Native Plant Law referenced above.

The Contractor shall provide a Notice of Intent to Clear Land 30-day notice in advance of construction to the Arizona State Department of Agriculture and Horticulture to enable the native plant investigator to survey and identify the plants involved and determine their status and salvageability. The Arizona Department of Agriculture and Horticulture is to identify all native plants prior to relocation by the Contractor or removal by the Contractor's Arizona Licensed Salvager.

Prior to the commencement of clearing and excavation work, the Contractor shall submit photographs and native plant inventory along the pipeline route.

Adjustments in the pipeline alignment to avoid a Native Plant shall require the Engineer's approval, and no additional compensation will be made for such alignment changes.

Protected native plants are not to be transported off the job site or offered for sale by the Contractor. All designated protected native plants removed shall be replanted by the Contractor—or replaced in kind if not transplantable—at selected sites within the public right-of-way and/or easements as required by the Native Plant Inventory and Salvage Report and Native Plant Preservation Plan or approved by the Engineer.

Plant Protection During Construction. Tagging required of all Protected Native Plants designated by the approved Native Plant Preservation Plan.

Fencing Requirements. All Protected Native Plants designated by the approved Native Plant Preservation Plan to be preserved in place, and all areas designated to remain undisturbed or as natural open space (easement limits) shall be fenced off per Development Standard No. 2-06.2.2.F (3/8-inch high visibility rope, 66-inch T-post 50 feet on center). Fencing shall remain in place for duration of construction activities.

All costs associated with fencing shall be included in the unit price bid per linear foot for the new transmission main.

SURFACE RESTORATION

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required to restore all non-pavement surfaces disturbed by construction or damaged by the Contractor, in accordance with the provisions of the project plans, special specifications, applicable jurisdictional requirements, or as may be ordered by the Engineer.

EXECUTION

General. All work shall be in accordance with the applicable provisions. The areas in question shall be restored to as good as or better than their original condition as approved by the Engineer or Company Representative.

Warranty. In addition to the warranty provisions of the General Provisions, all replacement plantings shall be warranted by the Contractor for a period of 1 year from final acceptance of the project. Establishment of planting materials shall conform to the applicable provisions of these standards and the approved project documents.

Cleanup. The Contractor shall not allow debris and unsalvageable material to accumulate on the project site. In no case shall the Contractor allow such debris and material to obstruct driveways, pedestrian-ways, or drainage facilities. All debris and unsalvageable material shall be hauled off from the project within 5 working days of its removal. Debris and unsalvageable material shall be disposed of in accordance with all applicable ordinances and regulations.

Inspection. All work within the public right-of-way or easement shall be subject to a final inspection by personnel from the jurisdiction responsible for the right-of-way.

FENCE

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for constructing chain link fence and gates—including polyethylene inserts and security barbed wire—at the locations and in accordance with the details shown on the plans, GCEC-approved standard details, and the requirements of these specifications. The chain link fabric shall be 72 inches high unless otherwise noted on the plans or in the special specifications. Chain link fence shall be constructed of zinc-coated steel fabric, posts, hardware, and fittings.

Delivery, Storage, and Handling. Chain link fence fabric, posts, rails, gates, redwood pickets, and barbed wire shall be delivered to the site, stored, and handled in a manner to avoid any damage to the materials or galvanized coating. Fence materials shall be stored and protected from damage, as well as dirt, mud, oil, paint, grease, and all other deleterious materials.

PRODUCTS

Materials.

(A) General. All fencing material may be sampled and tested in accordance with the applicable material standards specified herein.

(B) Concrete. Portland cement concrete for post footings shall conform to the requirements of Section 0301 and be Class C.

(C) Posts.

(1) Round Pipe. Posts shall be zinc-coated (galvanized) round steel pipe conforming to the requirements of ASTM A53, Type E or S, Grade A Standard Weight, Schedule 40, or shall be round pipe conforming to all of the requirements of AASHTO M 181 for Grade 2 pipe.

In addition, posts shall be finished with an acrylic top coat having a nominal thickness of 0.0005 inch. A chromate chemical treatment of 30 micrograms per square inch shall be applied to the zinc coating prior to applying the acrylic top coat. All posts for plain chain link fence, including posts with polyethylene inserts, shall have an outside diameter of 2-1/2 inches. End, corner, and intermediate posts shall have an outside diameter of 3 inches.

CONSTRUCTION SURVEYING AND LAYOUT

GENERAL

Description of Work. The work under this Section shall consist of furnishing all materials, personnel, and equipment necessary to perform all surveying, staking, and verification of the accuracy of all existing control points noted on the plans. Included in this work shall be all calculations required for the satisfactory completion of the project in conformance with the plans and these specifications. The work shall be performed by a Registered Land Surveyor employed by the Contractor. All right-of-way monuments and lines shall be established by a Registered Land Surveyor employed by the Contractor.

The surveyor employed by the Contractor shall verify the accuracy of the control points established by the plans and shall set all stakes, including, but not necessarily limited to:

- Centerline stakes
- Offset stakes
- Reference point stakes
- Slope stakes
- Pavement lines
- Curb lines
- Grade stakes
- Stakes for sewer crossings, pipe, clearing, guard rail, fence, right-of-way markers, and survey monuments
- Blue tops for subgrade, subbase, and base courses
- Supplemental benchmarks and permanent as-built elevation marks
- All other horizontal or vertical controls necessary for complete and accurate layout and construction of the work

The Contractor shall perform all layout work and set all control points, stakes, and references necessary for carrying out construction unless otherwise stated. The Owner is not responsible for the survey/layout.

The Contractor shall not employ or engage the services of any GCEC employee for the performance of any of the work as described herein.

EXECUTION

Construction Requirements. Prior to beginning construction, the Contractor shall submit layout and grade data to the Engineer for approval using forms and procedures acceptable to GCEC. Layout data shall identify the project name, stationing, offsets, elevations, and cut information for all valves, connections, hydrants, services, fittings, and other appurtenances to be incorporated into the system.

The Contractor shall verify the accuracy of the control points established by the plans and shall set all stakes including, but not necessarily limited to:

- Centerline stakes
- Offset stakes
- Reference point stakes
- Slope stakes
- Pavement lines
- Curb lines
- Grade stakes
- Stakes for sewer crossings, pipe, clearing, guard rail, fence, right-of-way markers, and survey monuments
- Blue tops for subgrade, subbase, and base courses
- Supplemental bench marks and permanent as-built elevation marks
- All other horizontal or vertical controls necessary for complete and accurate layout and construction of the work

If errors are discovered during the verification process, and control points do not agree with the geometrics shown in the plans, the Contractor shall promptly notify the Engineer in writing and explain the problem in detail. The Engineer will advise the Contractor within 5 working days of any corrective actions that may be deemed necessary.

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The surveyor employed by the Contractor shall be responsible for the proper layout and accuracy of all property markers and section monuments required by the project plans.

The Contractor's layout shall comply with the following requirements:

(1) All projects will be stationed at a minimum of 50-foot intervals.
(2) Curves with a radius of 300 feet or less shall be stationed every 25 feet; curves with a radius greater than 300 feet shall be stationed at least every 50 feet. All tangent sections shall be stationed at intervals not exceeding 50 feet.

(3) Cut information for the end location of services, fire hydrants, and stub-outs shall be provided. Cut information shall be indicated to the top of curb or—where no curb exists—to the finish grade. All cuts for the pipe line will be to pipe invert. Stationing and cut information shall be provided at both the main and end location for fire hydrants, stub-outs, and ARVs, while services shall require this information only at their end locations.
(4) Layout/cut sheets shall indicate any unusual conditions (i.e., additional cut, extra cover, drainages, etc.).
(5) Construction staking shall clearly and accurately reflect the information on the layout forms. Grade stakes shall contain legible station, offset, and cut data.
(6) Offset hubs shall be located so as to avoid disturbance during construction.
(7) Water mains shall be installed with a minimum 48 inches of cover from finished grade except where a greater depth is shown on the approved plans or required by field conditions. During construction, water mains shall maintain not less than 36 inches of temporary cover unless otherwise approved in writing by the Engineer and protected as directed by GCEC.
(8) Water mains installed within rights-of-way that are not at final finished grade shall be installed deep enough to maintain the minimum 48 inches of cover after final grading, as shown on the approved plans or as directed by the Engineer.

The Contractor shall exercise care in the preservation of stakes, references, and bench marks, and shall reset them at no additional cost to GCEC when any are damaged, lost, displaced, or removed. The Contractor—at his/her expense—shall replace "in kind" any existing survey monumentation damaged or disturbed during construction, including property pins. This replacement shall be made by an Arizona Registered Land Surveyor and will require a Record of Survey to be filed with the Graham County Recorder's Office.

Any discrepancies in grade, alignment, earthwork quantities, locations, or dimensions detected by the Contractor shall immediately be brought to the Engineer's attention. No changes in the project plans will be allowed without the Engineer's approval.

The Owner reserves the right to make inspections and random checks of any portion of the staking and layout work. If, in the Engineer's opinion, the work is not being performed in a manner that will assure proper controls and accuracy, the Engineer will order any or all of the staking and layout work redone at the sole cost of the Contractor and at no additional cost to GCEC.

If any portion of the Contractor's staking and layout work is ordered redone, resulting in additional rechecking by the Engineer, the Owner shall be reimbursed for all costs of such additional checking. The amount of such costs will be deducted from the Contractor's monthly

estimate. Layout/cut sheets shall be submitted for the Engineer's approval. Layout must be verified by the Engineer prior to issuance of the Notice to Proceed.

Inspection of the Contractor's layout by the Engineer and the acceptance of all or any part of it shall not relieve the Contractor of his/her responsibility to secure the proper dimensions, grades, and elevations of the several parts of the work.

WORKMANSHIP

GENERAL

Description of Work. All work shall be executed with the highest quality workmanship and in full compliance with all applicable codes, ordinances, plans, specifications, standard details, and OSHA requirements.

Inspection. Graham County Electric Representatives shall be authorized to inspect all work and furnished materials. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. Items of work requiring inspection prior to being backfilled by the Contractor include, but are not limited to:

- Trench depth and location
- Pipe materials and installation
- Pipe fittings and installation
- Thrust restraints
- Fire hydrant installation
- Temporary plugs
- Taps and tie-ins
- Services
- Drain assembly
- Bedding
- Tracer wire
- Detectable and marking tape installation

EXCAVATION

The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the plans, and including excavation ordered by the Engineer of compacted backfill for the purpose of making density tests on any portion of the backfill

Trenches for a single pipe shall conform to the dimensions in the following table.

TRENCH WIDTHS		
Size of Pipe (Nominal Diameter)	**Maximum Width at Top of Pipe Greater than O.D. of Bell**	**Minimum Width at Springline Each Side of Pipe Barrel.**
Rigid Pipes:		
Less than 18 Inches	16 inches	6 inches
18 inches to 24 inches inclusive	19 inches	7.5 inches
Flexible Pipes:		
Less than 18 inches	20 inches	8 inches
18 inches to 24 inches inclusive	23 inches	9.5 inches

The width of the trench shall not be greater than the maximum indicated in above Table, at and below the level of the top of the pipe. The width of the trench above that level may be made as wide as necessary for shoring, bracing, and for proper installation of the work.

If the maximum trench width as specified in above Table is exceeded at the top of the pipe, additional load bearing capacity to compensate for the increased pipe loading may be required by the Engineer. The Contractor shall provide, at no additional cost to the Contracting Agency, the additional load bearing capacity. This may require changing the material requirements of initial backfill, a higher strength pipe, a concrete cradle, cap or encasement, or other means approved in writing by the Engineer. Where safety or undermining situations occur, a controlled low strength material (CLSM) backfill may be used as needed.

Multiple pipe installations in a single trench shall be installed in accordance with details on the plans or in the special provisions.

Any work done or materials used without inspection by GCEC Company Representative may be ordered uncovered and removed or replaced at the Contractor’s expense, even if uncovered work

is deemed acceptable. It is the Contractor's responsibility to schedule the necessary inspections prior to any work taking place.

Contractor. The Contractor shall at all times employ sufficient labor and equipment to fulfill the work required by the specifications, standard details, and plans. All workers shall have sufficient skill and experience to properly perform the work assigned. Workers engaged in special or skilled work shall have sufficient experience in such work and in operating the equipment required to perform all work properly and satisfactorily.

Non-Conformance Report (NCR). When an issue of conflict, non-conformance to specifications, or Contractor poor performance cannot be resolved by the Construction Inspector, Construction Inspector Supervisor, or Contractor Superintendent, the Lead Inspector will notify the GCEC Water Department or designated engineering authority. Construction Management will schedule a meeting with the Contractor, and a Non-Conformance Report shall be issued to the Contractor and GCEC. The NCR will list the date, problem, and proposed solutions, and must be signed by the Contractor's onsite superintendent, the designated GCEC representative, and the Inspector before continuation of work. If the incident is not resolved, the project or water work will be stopped and will not resume until a resolution is achieved.

DUCTILE IRON PIPE

GENERAL

Description of Work. The work under this Section shall consist of furnishing ductile iron pipe and fittings. All materials must comply with the Approved Materials List attached hereto as Appendix A. Installation of ductile iron pipe shall be in accordance with the details shown on the plans and the requirements of these specifications.

Delivery, Storage, and Handling. Ductile iron pipe shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer.

During shipment and storage, the pipe ends shall be securely covered. Pipe delivered to a project without the ends covered will be rejected and removed from the site. Cleaning of contaminated pipe is not allowed.

PRODUCTS

Materials.

Ductile Iron Pipe. Ductile iron pipe shall comply with the most recent revision of the standards shown in Appendix B. (B) Pressure Class. Ductile iron pipe shall be Class 350 for diameters up to 12 inches. The pressure class of ductile iron pipe greater than 12 inches in diameter shall be Class 250 or as specified on the plans or in the special specifications. (C) Cement Mortar Lining. Ductile iron pipe for potable water installations shall be supplied with a shop-applied cement-mortar interior lining of standard thickness in accordance with ANSI A21.4/AWWA C104. Ductile iron pipe for reclaimed water installations shall have a double thickness cement-mortar interior lining in accordance with the noted ANSI/AWWA Standard. Any delamination of the cement-mortar lining will not be accepted.

EXECUTION

General. Ductile iron pipe shall be furnished with either bell-and-spigot, mechanical, or flanged joints as specified on the plans, in the special specifications, or as directed by the Engineer. Restrained joints shall be in accordance with Joints sections. Blind flanges shall be cast iron or ductile iron. Steel flanges will not be permitted.

Installation.

General. Installation of ductile iron pipe, including polyethylene encasement, shall conform with the applicable requirements of AWWA C600, AWWA C105, AWWA M41.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the pipe, fittings, and appurtenances being installed.

POLYVINYL CHLORIDE (PVC) PIPE

GENERAL

Description of Work. The work under this Section shall consist of furnishing polyvinyl chloride (PVC) pipe and all required fittings, as well as installing the PVC pipe, all in accordance with the details shown on the plans and with the requirements of these specifications and the Approved Materials List.

Delivery, Storage, and Handling. PVC pipe shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer.

During shipment and storage, the pipe ends shall be securely covered. Pipe delivered to a project without the ends covered will be rejected and removed from the site. Cleaning of contaminated pipe is not allowed. PVC pipe shall be stored in a manner such that it is protected from exposure to sunlight and/or extreme heat. Sunburned pipe is not allowed.

PRODUCTS

Materials.

Polyvinyl Chloride Pipe. PVC pipe shall comply with the approved materials requirements and applicable AWWA standards adopted by GCEC.

Pressure Class. Unless otherwise specified on the plans or in the special specifications, 4- to 12-inch PVC pipe shall be dimension ratio 14 (DR 14), pressure class 305 (cast iron O.D.). 16-inch PVC pipe shall be dimension ratio 18 (DR 18), pressure class 235 (cast iron O.D.).

EXECUTION

General. PVC pipe shall be furnished with bell-and-spigot joints. Elastomeric gaskets shall be furnished for all joints. Restrained joints shall be in accordance with Section 1406.

Installation.

General. Installation of PVC pipe shall conform to the applicable requirements of and AWWA M23. PVC pipe bell and spigot joints shall be assembled/installed with no horizontal or vertical

joint deflection and no longitudinal pipe bending. The Contractor shall use standard approved bends/fittings or a manufacturers specifically designed gasketed joint to achieve pipe deflection.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the pipe, fittings, and appurtenances being installed.

Tapping. Tapping shall be performed in accordance with the taps-into-water-lines requirements of these standards. Size-on-size tapping for pipe 12 inches in diameter and larger will not be accepted.

THRUST RESTRAINT

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required to resist the hydrodynamic thrust forces acting to separate the joints of water mains and appurtenances, in accordance with the details shown on the project plans and with the requirements of these specifications.

Submittals. When specified in the special specifications or required by the Engineer, shop drawings and manufacturer's literature shall be submitted to the Engineer for all materials and components.

All submittals shall reference the Applicable Work order/job number

Delivery, Storage, and Handling. Joint restraint devices shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions.

PRODUCTS

Materials.

Ductile Iron Pipe (4- to 12-inch DIP only). When mechanically restrained joints are required for ductile iron pipe, they shall comply with the Approved Materials List. Mechanically restrained joints shall be manufactured integrally with the pipe or provided as accessory mechanisms as described in this Section.

Field welding of ductile iron pipe for joint restraint shall not be permitted. Cadwelds for corrosion protection are acceptable.

Mechanical joint retainer gland restraints for ductile iron pipe shall be designed to fit standard mechanical joint bells with standard "tee" head bolts conforming to ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53. Glands shall be manufactured of ductile iron conforming to ASTM A36, Grade 60-42-10. Set screws shall not be permitted. Mechanical joint restraint devices shall have a working pressure of at least 250 pounds per square inch with a minimum safety factor of 2 to 1.

Glands shall be provided with a restraining mechanism consisting of a sufficient number of individually set gripping surfaces that impart a wedging action against the pipe, increasing in resistance with increasing pressure. The gripping surfaces shall incorporate twist-off nuts to ensure proper setting. Restraint mechanisms shall be installed in accordance with the manufacturer's recommendations. DIP 16 inches in diameter and larger will need to be submitted for Engineer approval.

Polyvinyl Chloride Pipe (PVC). Polyvinyl chloride pipe joints shall be secured by means of a mechanical restraint device on the Approved Materials List.

Restraint harnesses shall consist of:

(1) A split ring that fits behind the bell
(2) Either a split or full restraint ring that installs on the spigot end
(3) Tie bars or tee bolts connecting the two rings

The harness restraint may be split to enable installation after the pipe spigot has been installed into the bell. All components comprising the restraint harness shall be manufactured of ductile iron conforming to the requirements of ASTM A536. Each ring shall have either serrations on its full inside diameter (360 degrees) or a sufficient number of individually adjusted gripping surfaces.

All clamping bolts, tie bars, tee bolts, nuts, and washers shall be manufactured of either:

- Corten high-strength, low-alloy structural weathering steel (or approved equal) in accordance with ASTM A242 or ASTM A588
- Type 316 stainless steel with Xylan-coated stainless-steel nuts

Typically, external joint restraints employ individual external clamps that fit behind the bell and around the pipe, and tie rods between the clamps. All restraints shall be encased with 8-millimeter polyethylene wrap in accordance with AWWA C105, Method C.

Thrust restraint utilizing Portland cement concrete thrust blocking shall be only for modifications to existing pipe lines or as may be approved by the Engineer. Portland cement concrete thrust blocks shall comply with the requirements of this section.

EXECUTION

General. The Contractor shall provide and install thrust restraint at all points of directional change (i.e. fittings, valves, bends, tees, and plugs). All thrust restraint methods shall be installed prior to pressure testing. Wooden blocks, wedges, or other non-permanent techniques will not be

permitted. The Contractor is responsible for providing restraint against thrust loads during testing.

The length of pipe to be restrained shall be as indicated on the plans, shop drawings, and as called for in this standard.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the thrust restraint being installed.

Welding. Welded joint restraint for Steel water pipe shall be in accordance with the pipe manufacturer's recommendations. The length, size, and type of weld shall comply with the requirements of the approved plans and shop drawings.

Field welding shall be in accordance with the American Welding Society and AWWA C206. Welding shall be performed by certified welders.

Field welds on steel water pipe shall be placed in passes not more than 1/8 inch thick unless otherwise approved by the Engineer. Size and type of electrodes, current, and voltages shall be in accordance with the manufacturer's requirements and subject to the Engineer's approval. Particular attention shall be given to the alignment of edges to be joined in order to effect complete fusion and penetration throughout the root of the weld. Welds shall contain no valley or undercuts in the center or edges of the weld. Each pass shall be thoroughly cleaned of dirt, slag, or flux before the succeeding welding pass is applied.

All completed field welds on steel water pipe joints shall be visually inspected. Non-destructive testing of field welds may be specified in the special specifications for critical locations, or be required by the Engineer to supplement visual inspections. When non-destructive testing is required, the Agency shall pay for the initial test. In the event of rejected welds, all retests shall be at the Contractor's sole expense. Porosity, cracks, trapped welding flux, or other defects in welds discovered during field inspection shall be completely ground out in a manner that will permit proper and complete repair by welding. Under no circumstances will caulking of defective welds be permitted.

Welding of joints shall be by the electric arc process in accordance with the applicable requirements of AWWA C206. Field welding shall commence as soon as practicable after the laying operation. Field welds shall be completed before lining or coating of joints. All required field welds shall be specified in the shop drawings and pipe design calculations.

Portland Cement Concrete Thrust Blocks.

The use of Portland cement concrete thrust blocks is not permissible except in the following cases:

- As shown on the plans or with the Engineer's approval.
- For installation of approved tapping sleeves

When approved, Portland cement concrete thrust blocks shall be placed against undisturbed earth in accordance with GCEC-approved standard details. Where it is not practicable to place the concrete thrust block against undisturbed earth, the fill material between the pipe's bearing surface and the undisturbed soil shall be compacted to a minimum of 95 percent of the maximum density as determined in accordance with the requirements of Arizona Test Methods 225, 226, 227, 230 or 231, and 232.

Thrust Restraints on Tapping Sleeves. Thrust restraints for tapping sleeves will follow the concrete thrust block per standard.

Corrosion Control. Joint restraint devices of dissimilar material shall be protected against corrosion in accordance with AWWA standards.

TAPS INTO WATER LINES

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, tools, and equipment, as well as performing all operations necessary for drilling and tapping any water main—new or existing—in accordance with the details shown on the plans, GCEC-approved requirements, and the requirements of these specifications.

Submittals. Shop drawings, details, and calculations shall be submitted for all taps into concrete cylinder pipe and welded steel pipe. All submittals shall reference the applicable GCEC work order, project number, or approved plan number. GCEC must approve concrete cylinder pipe taps in writing prior to any taps.

Delivery, Storage, and Handling. Tapping sleeves, valves, copper service materials, and tapping equipment used in the tapping operation shall be delivered to the site and stored in a manner such that it is protected from damage.

EXECUTION

General. All work shall be in accordance with the applicable provisions as specified herein.

Direct tapping is not allowed.

Dry tapping of new water mains shall only be permitted when approved in writing by the Engineer. Requests to dry tap shall include the proposed methods of flushing to ensure removal of all debris from the line.

The cutting tool shall be a shell-type cutter that will retain the coupon (cookie) and shall be designed to accommodate the wall thickness of the pipe being cut.

Shell cutters and pilot bits shall be maintained sharp and of proper dimension to minimize damage to the pipe and preserve the integrity of the remainder of the pipe wall. Shell cutters shall have a minimum diameter of 90 percent of the required tap size. Shell cutters shall produce clean and even entry cuts under normal drilling machine stresses or they shall be replaced.

Tapping sleeves and tapping equipment shall be supported independently from the pipe during tapping operations.

Placement of the tapping machine on the pipe shall be done in accordance with the tapping machine manufacturer's recommendations.

Tapping sleeves and valves shall be used when a service connection or lateral larger than 2 inches in diameter must be installed in a water main.

Size on size tapping for pipe 14 inches in diameter and larger will not be accepted. Service connection taps shall be in accordance with this standard.

RESILIENT-SEATED GATE VALVE

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for the installation of 4-inch through 24-inch resilient seated gate valves, all in accordance with the details shown on the plans and requirements of these specifications. Metal-sealed gate valves shall not be used.

Delivery, Storage, and Handling. Resilient-seated gate valves shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer.

PRODUCTS

Materials.

Standards. Resilient-seated gate valves and the materials used in their manufacture shall comply with AWWA C509, AWWA C515 and appear on the Approved Materials List.

Pressure Class. Design pressure for resilient-seated gate valves shall be 200 pounds per square inch for valves 12 inches smaller, and 150 pounds per square inch for valves 16 inches and larger. Valves for operating pressures other than the above shall be as specified on the plans or in the special specifications.

Component Parts. Unless otherwise noted, component parts for resilient-seated gate valves shall be in accordance with AWWA C509 and AWWA C515. All components of resilient seated valves shall be tested and certified by an approved testing laboratory located in the United States. All parts shall be readily available and shall meet the following requirements:

(1) The valve manufacturer's name along with the valve model number, size, and year of manufacture shall be cast on the body.
(2) The resilient seat shall be fastened to the gate using either mechanical, stainless steel fasteners or vulcanizing methods in accordance with the requirements of ASTM D429 and the manufacturer's recommended procedures.
(3) Resilient-seated gate valves shall be provided with a 2-inch square operating nut. When specified on the plans, a hand wheel shall be used. The direction to open the valve shall be to the left (counter clockwise), and a direction indication for opening the valve shall be

cast on the operating nut. Position indicators shall not be required unless specified on the plans or in the special specifications. Valves must have a minimum of 2 turns per inch of diameter.

(4) All interior ferrous surfaces exposed to fluid flow—including the gate—shall be factory coated with a thermosetting or fusion epoxy coating. The coating shall be safe for potable water systems in accordance with AWWA C550. The minimum coating thickness shall be 10 millimeters.

(5) The wedge shall be manufactured of ductile iron and fully encapsulated in a molded EPDM resilient material resistant to heat, corrosion, hydrolysis, tuberculation, abrasion, and bacteria, and shall comply with AWWA C509

(6) All exterior ferrous surfaces, including nuts and bolts, shall be field coated with a fast curing sealant from the Approved Materials List (Appendix A) for this use. Application of the sealant shall be accordance with the manufacturer's recommendations. Nuts and bolts may be manufactured of ASTM type 304 or 316 stainless steel in lieu of being coated.

(7) All internal parts shall be accessible for repair or replacement without removing the valve body from the pressure line. The stem shall be sealed by using a minimum of 2 O-rings. The O-rings shall be located above the stem collar and shall be replaceable under pressure with the valve in the open position.

(8) The diameter of the internal passageway shall have a nominal inside dimension equal to the valve size or larger. The valve shall provide an unobstructed waterway in the full open position making the valve applicable for tapping applications.

(9) Valve stem shall be a high-strength, low-zinc bronze, 40,000-psi yield strength, 70,000-psi tensile strength, with not less than 10 percent elongation. Stem bronze shall conform to the requirements of AWWA C509 Section 2.

(10) Valve ends shall be mechanical joint, conforming to AWWA C110, unless otherwise specified in the Contract Documents. Connection bolts and nuts shall be manufactured of Corten steel or approved equal in accordance with ASTM A242.

(11) Where specified in the Contract Documents, valve ends shall be flanged in accordance with AWWA C110 for 125/150-pound flanges and ASME/ANSI B16.1 for 250/300pound flanges. Connection bolts and washers shall be manufactured of type 316 stainless steel, and nuts shall be manufactured of type 316 stainless steel with a Xylan coating or approved equal. No anti-seize compound shall be applied on flanged bolts.

EXECUTION

Installation.

General. Valves shall be installed in accordance with the valve manufacturer's recommendations. All valves shall be encased with an 8-millimeter polyethylene wrap in accordance with AWWA C105, Method C.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the valves and appurtenances being installed.

Seat Leakage Test. On the project site, at surface grade, and prior to installation, all gate valves 16 inches in diameter and larger shall be subject to an internal hydrostatic pressure test, equivalent to the pipe hydrostatic test pressure. Test duration shall be 15 minutes. The test shall be performed on one side using either a mechanical cap or flange with a 2-inch outlet rated equivalent to, or higher than, the test pressure. The valve wedge will act as the second side for testing, and the Engineer will determine the side to be tested. During the hydrostatic test, there shall be no leakage through the valve body, end joints or sealed wedge.

Valves. Prior to installation in the trench, valves 16 inches or larger shall be fully opened and closed by the Contractor to check the operation and ensure the valve fully seats. A record shall be made of the number of turns required to fully open or close the valve. This record shall be included on the as-built plans. The inside of the valve shall be thoroughly cleaned prior to valve installation.

COMBINATION AIR RELEASE VALVE

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for the installation of combination air release valves, all in accordance with the details shown on the plans, GCEC-approved standard details, and requirements of these specifications.

Submittals. In order to be accepted for incorporation into the work, the manufacturer's make and model of air release valve shall appear on the GCEC-approved materials list found in Appendix A of these standard specifications.

Delivery, Storage, and Handling. Combination air release valves shall be delivered to the site, stored in a dry place, and repainted after installation in accordance with the plans or special provisions.

PRODUCTS

Materials. Any reference made herein to air release valves shall be synonymous with combination (air release, air/vacuum) unless specifically stated otherwise.

Standards. Air release valves and the materials used in their manufacturer shall comply with the most recent revision listed in the Approved Materials List (Appendix A).

Pressure Class. Working pressure for air release valves shall be 150 pounds per square inch unless otherwise noted on the plans or in the special specifications.

Metal Component Parts. Air release valves covered by this specification are sized 1/2 inch through 6 inches unless otherwise noted. Component parts of the air release valves shall be in accordance with AWWA C512. All components of air release valves shall be tested and certified by an approved testing laboratory located in the United States. All component and repair parts shall be readily available.

Air release valves 3 inches in diameter and smaller shall be provided with a threaded connection. Valves 4 inches in diameter and larger shall be provided with an ANSI B16.1 Class 125 flanged inlet connection unless otherwise noted on the plans or in the special specifications.

Air release valves shall consist of single or dual housing. The body and cover shall be of gray cast iron in accordance with ASTM A126, Class B, or ductile iron in accordance with ASTM A536, Grade 65-45-12. The valve trim, float, and all working parts shall be constructed of stainless steel, brass, or other corrosion-resistant material.

Lightweight Component Parts. Air release valves shall have a reinforced nylon body and shall be sized 3/4 inch through 2 inches with a threaded connection. Lightweight air release valves shall be NSF 61 approved. ARV shall have a rolling seal with a polypropylene float.

Installation. General. Air release valves shall be installed above grade and in accordance with standard details. The air release line requires a tracer wire in accordance with the standard detail. Above-grade ARV shall be lightweight, with a reinforced nylon body, rolling seal, and polypropylene float, all NSF 61 approved.

Exterior Metal Surfaces. After the air release valve assembly has been installed, the Contractor shall apply an Outside Paint System (OPS) No. 2 to the entire assembly in accordance with AWWA D102. The coating shall be holiday free and have a minimum total dry film thickness of 6 millimeters.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the air release valves and appurtenances being installed.

Hydrostatic Test. Valves shall not be installed until after the pipeline has been tested, or ball valves shall be closed to isolate the air release valves during test.

PRESSURE REGULATING VALVE

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for the installation of pressure regulating valves with check features in accordance with the details shown on the plans and requirements of these specifications.

Submittals. In order to be accepted for incorporation into the work, the manufacturer's make and model of pressure regulating valve shall appear on the list of approved products found in the Approved Materials List. Pressure regulating valves 3 inch and larger shall be approved by the engineer, or shown on the plans or specifications.

Delivery, Storage, and Handling. Pressure regulating valves shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer.

PRODUCTS

Materials. Pressure Rating. Pressure regulating valves shall have a working pressure rating of 250 pounds per square inch. The pressure setting adjustment range shall be from 30 to 300 pounds per square inch. Pressure regulating valves for service conditions exceeding these pressures shall be as specified in the plans or special specifications. Individual services line ratings will be covered on the plans.

Component Parts.

(1) **General.** The main body and cover shall be either ductile iron in accordance with ASTM A536, or stainless steel (type 304 or 316). Flanges shall be 150 pounds.

The main valve trim shall be type 304 or 316 stainless steel in accordance with ASTM A167, ASTM A240, or ASTM A276. The pilot control shall be cast bronze in accordance with ASTM B62, with type 303 stainless steel trim.

Pressure regulating valves shall be hydraulically operated, diaphragm-type globe valves with pilot control system and a pressure setting adjustment feature.

Pressure setting adjustment shall be accomplished with a single adjusting screw. The adjustment screw shall be protected by a screw-type housing that can be sealed to discourage tampering.

Pressure regulating valves shall be capable of holding downstream pressure constant with a fluctuating inlet pressure.

The main valve and pilot valve closure shall be drip tight when downstream pressures exceed the control pilot's pressure setting.

The main valve and pilot control system construction shall not include pistons or external packing glands.

The main valve shall have a single removable seat and a resilient disc. The stem shall be guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat.

The pilot control shall be a direct-acting, adjustable, spring-loaded, normally open diaphragm valve, designed to permit flow when controlled pressure is less than the spring setting. The control system shall include a fixed orifice.

The pressure regulating valve shall have a check feature that—if a pressure reversal occurs—will close the valve to prevent return flow.

(2) **External Coating.** All exterior ferrous surfaces shall be factory coated in accordance with AWWA C550 or with an FDA-approved fusion bonded epoxy. Minimum total dry film thickness of this coat shall be no less than 12 millimeters. Surface preparation shall

be in accordance with SSPC-SP 10 for near white blast cleaning prior to prime coat application. Nuts and bolts may be stainless steel conforming to ASTM type 304 or 316.

EXECUTION

General. Pressure regulating valves shall be installed in a horizontal position as indicated on the plans or as specified in the special specifications.

Installation.

General. Valves shall be installed in accordance with the manufacturer's recommendation.

Pressure Regulating Valves. Pressure regulating valves shall be installed above grade.

Installation. Installation of pressure regulating valves under this Section shall include the installation of 2 pressure gauges.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the valves and appurtenances being installed.

Testing. All valves shall be hydrostatically leak tested in accordance with the pressure-testing requirements of these standards.

VALVE BOX AND COVER

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for the installation of valve boxes and covers in accordance with the requirements of these specifications in standard detail.

Submittals. All submittals shall refer to the applicable GCEC work order, project number, or approved plan number.

Delivery, Storage, and Handling. Valve boxes and covers shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer.

PRODUCTS

Materials. Valve boxes and covers shall be heavy cast iron in conformance with ASTM A48, Class 30B. They shall also conform to the requirements of the standard. Valve boxes shall be one piece with inside fitting cover, and shall be equipped with lugs or lips for setting in concrete. Covers shall be marked "Water Valve" .

EXECUTION

Installation. Valve boxes and covers shall be installed in accordance with standard detail.

Existing Valve Box and Cover Adjustments.

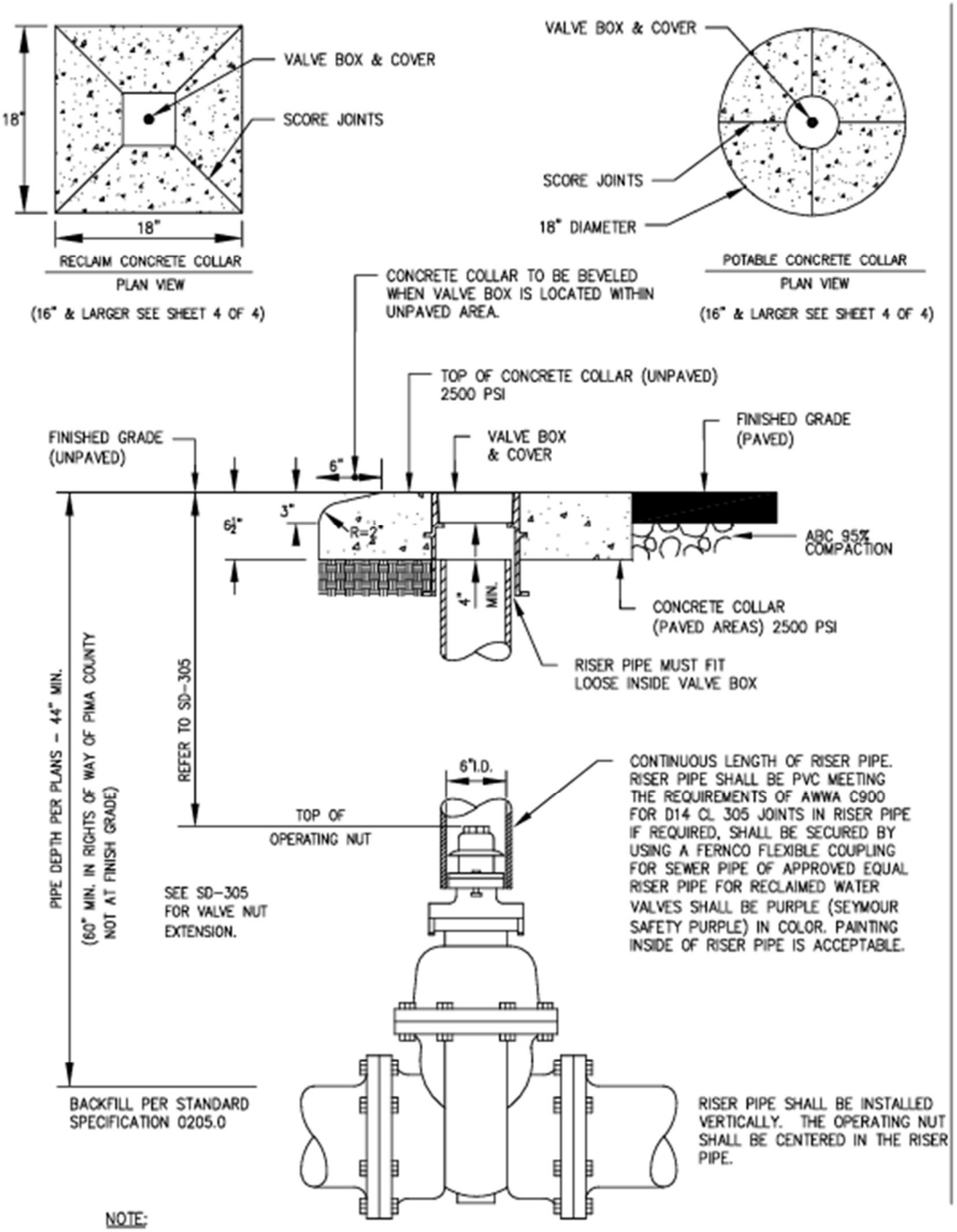
Description. The work under this item shall consist of furnishing all labor, equipment, and materials required for adjusting existing valve boxes and covers at the locations shown on the project plans and in accordance with the requirements of these special provisions.

Materials. The Contractor shall protect all existing water valve boxes and covers during the course of the work. For badly worn boxes and covers—or for valves lacking boxes or covers—the Contractor shall notify GCEC Water Department's Construction foreman, who shall make arrangements for the Contractor to obtain, at no expense, new valve boxes and covers from the Water Department. The Contractor shall pick up the new valve boxes and covers from GCEC construction yard between the hours of 6 a.m. and 3:30 p.m., Monday through Thursday. However, this does not relieve the Contractor of his/her responsibility to provide new valve boxes and covers for new valves as called for and indicated on the plans.

Construction Requirements. The Contractor shall adjust existing water main valve boxes and covers to the level of the new pavement of finished grade.

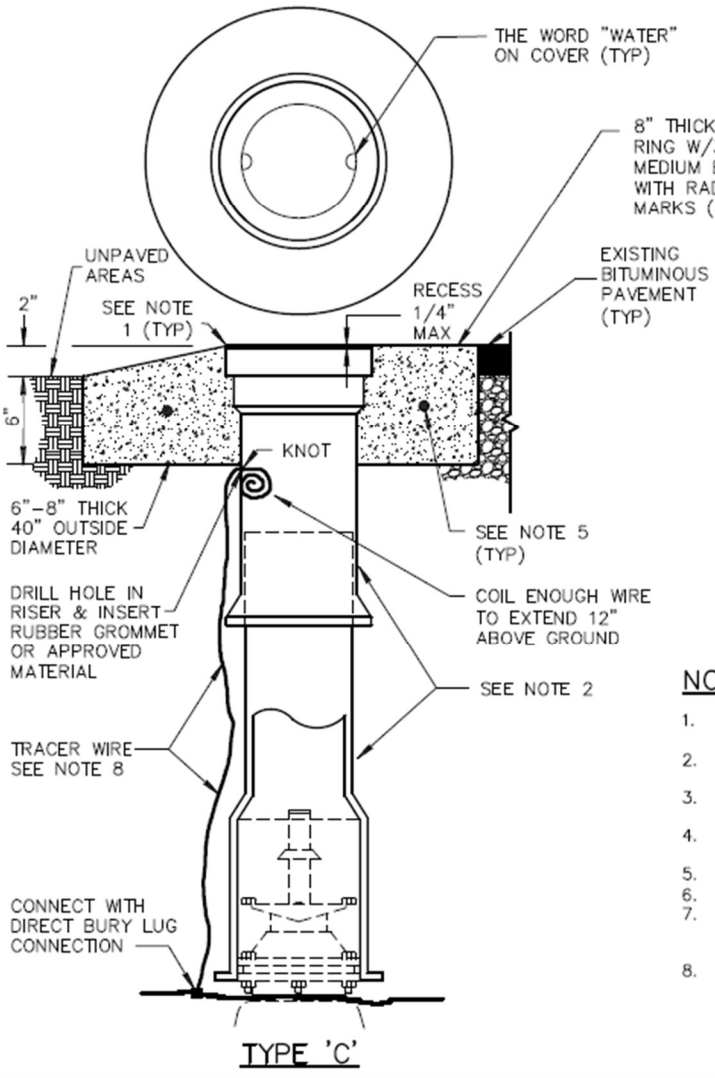
Methods of Measurement. Adjustment of existing valve boxes and covers will be measured by the unit for each valve box and cover adjusted.

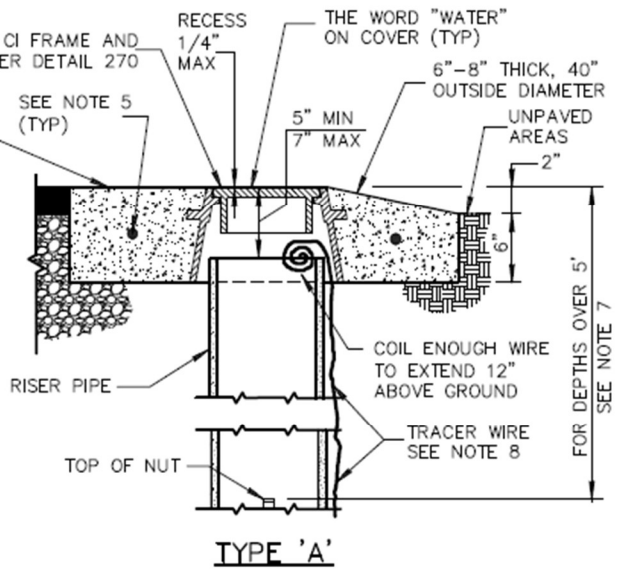
Basis of Payment. The accepted quantities of adjusted existing valve boxes and covers, measured as specified above, will be paid at the contract unit price per adjustment. This price shall be full compensation for the work, complete in place.



NOTE:

* CONCRETE COLLAR TO EXTEND TO FINISHED GRADE WHEN INSTALLED IN CONCRETE PAVEMENT. ½" BITUMINOUS JOINT MATERIAL SHALL BE INSTALLED BETWEEN CONCRETE COLLAR AND CONCRETE PAVEMENT.





NOTES:

1. VALVE BOX OR FRAME SHALL BE ADJUSTED TO THE FINISHED GRADE PRIOR TO PLACEMENT OF CONCRETE.
2. USE DEEP SKIRTED LID (4" OR MORE) TYPE, SLIDING ADJUSTABLE CAST IRON VALVE BOX C.I. MIN 30,000 P.S.I.
3. GROUND BELOW CONCRETE RING AND CONCRETE RISER PAD TO BE COMPACTED TO 95% MAXIMUM DENSITY.
4. CUT RISER PIPE TO LENGTH IN FIELD. **CAUTION:** IF EXISTING RISER IS ASBESTOS-CEMENT PIPE (ACP) FOLLOW OSHA GUIDELINES FOR WORKING WITH ACP.
5. #4 REINFORCING STEEL HOOP EQUALLY CENTERED HORIZONTALLY & VERTICALLY.
6. CONCRETE SHALL BE CLASS "AA" PER SECTION 725.
7. WATER VALVE EXTENSIONS SHALL BE INSTALLED WHEN THE DIMENSION FROM FINISH GRADE TO THE TOP OF THE OPERATING NUT EXCEEDS 5 FEET. SEE DETAIL 393 FOR VALVE EXTENSION.
8. WHERE REQUIRED BY AGENCY, CONTRACTOR TO INSTALL TRACER WIRE PER SECTION 632 AND THIS DETAIL.

FIRE HYDRANTS

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for the installation of fire hydrants, all in accordance with the details shown on the plans and the requirements of these specifications.

Submittals. In order to be accepted for incorporation into the work, the manufacturer's make and model of fire hydrant shall appear on the Approved Materials List.

Delivery, Storage, and Handling. Fire hydrants shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions.

PRODUCTS

Materials.

Standards. Fire hydrants and the materials used in their manufacture shall comply with the Approved Materials List.

Working Pressure. Fire hydrants shall be designed for a working pressure of 150 pounds per square inch.

Component Parts. Unless otherwise noted, component parts for dry-barrel fire hydrants shall be in accordance with AWWA C502. All components of dry-barrel fire hydrants shall be tested and certified by an approved testing laboratory located in the United States. All component parts shall be readily available.

The fire hydrant's body between the elbow and the top cap shall be fabricated in two parts connected by a swivel flange or breakable flange that permits positioning of the nozzles in any desired direction.

The fire hydrant shall be installed such that when the fire hydrant barrel is broken through any cause, including vehicular damage—it can be replaced without disturbing or replacing the portion of the hydrant below the ground line. Provision shall be made in the manufacture of the stem to allow the stem to be disconnected from the parts above the break point. If breakable or sleeve-type couplings are used, they shall have sufficient torsional strength such that failure of

the stem shall occur at a point other than the coupling. The coupling shall be manufactured such that no parts shall be dislodged and fall into the barrel of the fire hydrant, and that the break shall not occur through the pins or bolts holding the coupling to the stem. All parts shall be removable from ground level without excavation of the fire hydrant.

The fire hydrant shutoff shall be of the compression type that provides for closure of the main valve with water pressure. The valve action shall provide positive shutoff at minimum closing torque. Wedge action closing gates and scissor-type main valves shall not be permitted.

The inlet connection shall be a mechanically restrained joint unless otherwise specified. The main valve opening shall be a minimum of 5-1/4 inches.

The fire hydrant shall be designed with O-ring seals to protect the operating stem and threads from water. The seals shall be of the double O-ring type. The O-rings shall move against a bronze, stainless steel, or other non-corrodible metal surface. O-rings shall comply with ASTM D2000.

Upper stem thread lubrication shall be accomplished with either oil or grease. When oil is used, it shall be in conjunction with a functional oil reservoir and oil filler port. The lubricant shall be suitable for a temperature range of -40 degrees F to +150 degrees F. Field lubrication shall be accomplished without disassembly of the unit.

Fire hydrants shall be provided with two 2-1/2-inch hose nozzles and one 4-1/2-inch pumper nozzle. Hose and pumper nozzle threads shall be in conformance with NFPA 194 for National (American) Standard Fire Hose Coupling Screw Threads.

Operating and nozzle cap nuts shall be tapered pentagon nuts not less than 1 inch high. The nut shall measure 1-1/2 inches from point to flat at its base and 1-7/16 inches at the top. Gaskets shall be installed on all nozzle caps. Gaskets shall be in long-life, black rubber in accordance with ASTM D2000. Unless specified on the plans or special specifications, nozzle cap chains shall not be installed. When specified, nozzle cap chains shall comply with the requirements of AWWA C502.

Fire hydrants shall open to the left (counter clockwise). The word “OPEN” and a directional arrow shall be cast in the top of the fire hydrant. Fire hydrants shall be manufactured with 2 drain holes and provided with an automatic and positively operating, non-corrodible drain. The drain valve shall open as the main valve is closed and vice-versa. The port and seat of the drain valve shall be bronze.

Fire hydrants shall be designed to accept 6-, 12-, or 18-inch extensions.

The shoe or base of the fire hydrant shall connect to a pipe of 6-inch nominal inside diameter unless otherwise noted on the plans. Use of 8-inch base connection hydrants is intended to maximize available flow to the hydrant while minimizing main velocities. Use and application of the 8-inch base hydrant shall be approved by GCEC and installed per approved plan. The internal surface of the shoe shall be coated with a 2-part thermosetting epoxy protective coating no less than 4 millimeters thick.

After shop priming, the outside of the fire hydrant above finished ground shall be thoroughly cleaned and then shop painted with one coat of primer. The exterior of the fire hydrant above finished ground shall receive one finish coat of aluminum/silver industrial enamel matching the existing GCEC hydrant color.

Fire hydrants shall be manufactured with a main valve seat ring of bronze threaded into a bronze drain ring. A 360-degree drain channel shall have a minimum of 2 drain outlets.

EXECUTION

General. Fire hydrants shall be installed as indicated on the plans or as specified in the special specifications. Any changes to the fire hydrant location will require a plan revision approved by GCEC.

General. Fire hydrants shall be installed in accordance with GCEC-approved standard details.

Workmanship. All the Contractor's or subcontractor's personnel shall be skilled and knowledgeable regarding installation procedures for the fire hydrant and appurtenances being installed.

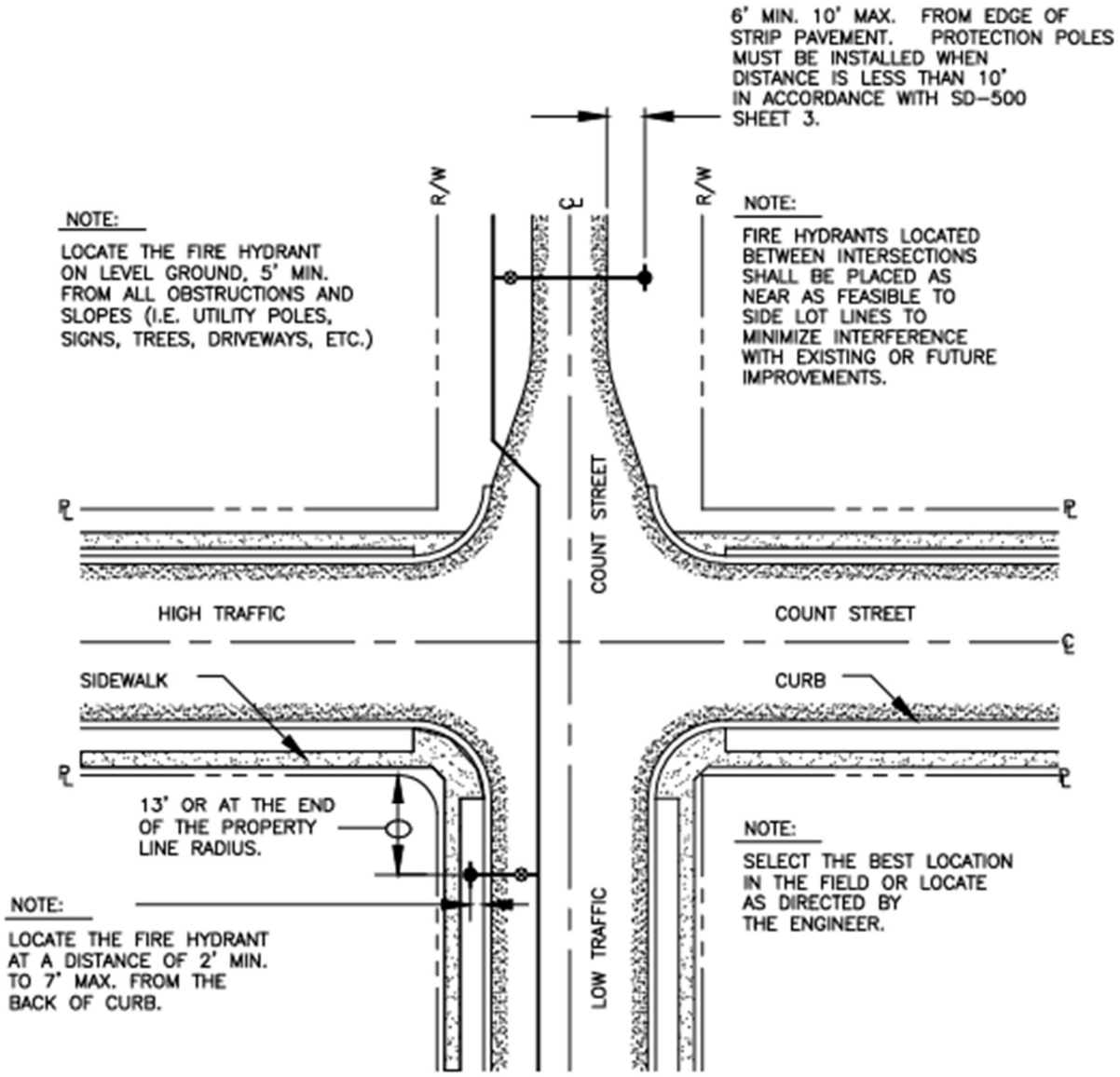
Supplemental Details. The minimum distance from the centerline of the lowest nozzle and finished grade shall be in accordance with GCEC-approved standard details.

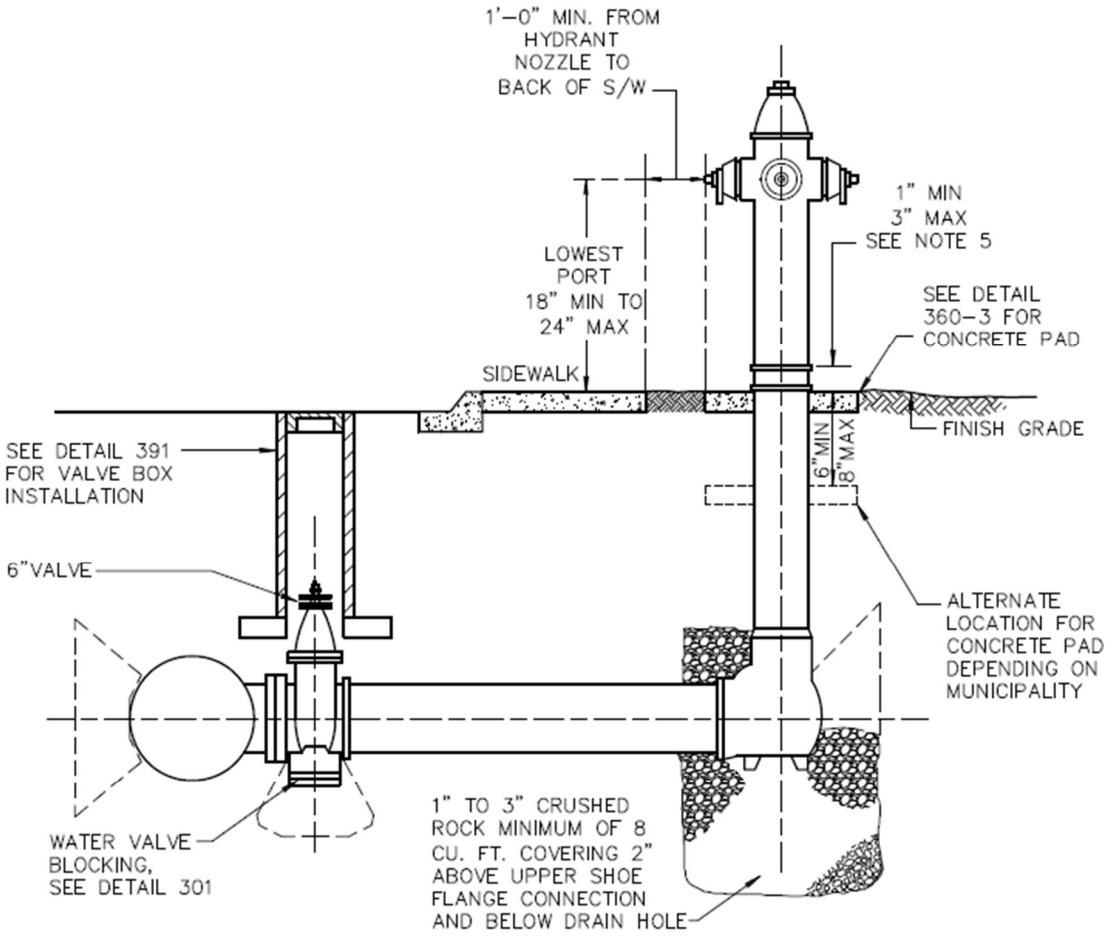
After installation, the Contractor shall paint the hydrant with one coat of aluminum/silver industrial enamel matching the existing hydrant color.

Thrust Restraint. Thrust restraint will be in accordance with the standard and must be pre-approved by GCEC.

Concrete thrust blocking, if required, shall be similar to the thrust blocking required for 6-inch, 90-degree bends called for GCEC Standard. Concrete thrust blocking shall only be used for extending existing pipe—which is not mechanically restrained—between the shoe and the main

tee. The minimum soil bearing area shall be 7.5 square feet. The Contractor shall ensure that the weep hole in the shoe of the fire hydrant is not obstructed by the concrete thrust blocking. Any concrete thrust blocking shall be placed after the fire hydrant is set in place and connected to the main line.


6' MIN. 10' MAX. FROM EDGE OF STRIP PAVEMENT. PROTECTION POLES MUST BE INSTALLED WHEN DISTANCE IS LESS THAN 10' IN ACCORDANCE WITH SD-500 SHEET 3.
R/W
℄
R/W
NOTE:
LOCATE THE FIRE HYDRANT ON LEVEL GROUND, 5' MIN. FROM ALL OBSTRUCTIONS AND SLOPES (I.E. UTILITY POLES, SIGNS, TREES, DRIVEWAYS, ETC.)
NOTE:
FIRE HYDRANTS LOCATED BETWEEN INTERSECTIONS SHALL BE PLACED AS NEAR AS FEASIBLE TO SIDE LOT LINES TO MINIMIZE INTERFERENCE WITH EXISTING OR FUTURE IMPROVEMENTS.
COUNT STREET
HIGH TRAFFIC
COUNT STREET
SIDEWALK
CURB
13' OR AT THE END OF THE PROPERTY LINE RADIUS.
NOTE:
SELECT THE BEST LOCATION IN THE FIELD OR LOCATE AS DIRECTED BY THE ENGINEER.
NOTE:
LOCATE THE FIRE HYDRANT AT A DISTANCE OF 2' MIN. TO 7' MAX. FROM THE BACK OF CURB.
LOW TRAFFIC



NOTES:

1. JOINTS BETWEEN THE VALVE AND THE MAIN SHALL BE FLANGED TYPE. JOINTS BETWEEN THE VALVE AND HYDRANT SHALL BE RESTRAINT OR MECHANICAL TYPE.
2. RESTRAINTS SHALL BE MECHANICAL RESTRAINT OR THRUST BLOCK PER DETAIL 380.
3. A FLANGE JOINT BY MECHANICAL JOINT VALVE SHALL BE USED AS THE TRANSITION BETWEEN THE JOINT TYPES.
4. PIPING BETWEEN WATER VALVE AND HYDRANT SHALL BE DUCTILE IRON.
5. SEE DETAIL 362 FOR LOCATION OF HYDRANT.
6. PUMPER CONNECTION SHALL FACE THE STREET.
7. NO VALVES ARE TO BE LOCATED IN CURB.
8. NATIONAL STANDARD THREADS REQUIRED ON ALL CONNECTIONS UNLESS OTHERWISE DIRECTED.
9. SEE DETAIL 360-3 FOR CONCRETE PAD.
10. CONTRACTOR TO VERIFY CORRECT COLOR WITH AGENCY REQUIREMENTS. ALL NEW FIRE HYDRANTS SHALL BE FACTORY PAINTED ONLY AND IN NEW CONDITION. ANY NEW OR RELOCATED FIRE HYDRANTS REQUIRING PAINT TOUCH-UP SHALL BE DONE USING THE MANUFACTURER'S SPECIFIED SYSTEM AND INSTRUCTIONS.
11. SEE SECTION 756 FOR HYDRANT MATERIAL.

FITTINGS, FLEXIBLE COUPLINGS, GASKETS, AND REPAIR CLAMPS

GENERAL

Description of Work. The work under this Section shall consist of furnishing all labor, materials, tools, equipment, and incidental items required for the installation of fittings, flexible couplings, and repair clamps in accordance with the details shown on the plans and the requirements of these specifications.

Submittals. In order to be accepted for incorporation into the work, the manufacturer's make and model of fittings, flexible couplings, and repair clamps shall appear on the GCEC-approved materials list in Appendix A of these standard specifications.

Delivery, Storage, and Handling. Fittings, flexible couplings, Gaskets, and repair clamps shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as may be modified by the plans, special specifications, or as directed by the Engineer or Company Representative.

PRODUCTS

Materials

(A) **Fittings.**

1) **Cast Iron and Ductile Iron Fittings.** Cast iron and ductile iron fittings shall meet the requirements of AWWA C110 and AWWA C153 for compact fittings. Working pressure for fittings 24 inches in diameter and larger shall be as indicated on the plans or in the special specifications.

   The interior surface of cast iron and ductile iron fittings shall be cement-mortar lined and sealed by the manufacturer in accordance with AWWA C104.

   All plugs and caps used for stub-outs shall be tapped for a 2-inch national pipe thread.

   Connection bolts and nuts for mechanical joint fittings shall be manufactured of Corten steel or approved equal in accordance with ASTM A242. For flanged fittings, connection bolts and washers shall be manufactured of type 316 stainless steel, and nuts shall be manufactured of type 316 stainless steel with a Xylan

coating or approved equal. No anti-seize compound shall be applied on flange bolts.

2) **Fabricated Steel Fittings.** Fabricated steel fittings shall meet the requirements of AWWA C208 and AWWA M11. The working pressure for steel fittings shall be as indicated on the plans or in the special specifications.

   The interior surface of steel fittings shall be cement-mortar lined and sealed by the manufacturer in accordance with AWWA C104. Liquid epoxy coating systems shall be in accordance with AWWA C210. Fusion-bonded epoxy coatings shall be in accordance with AWWA C213 as specified on the plans or in the special specifications.

(B) **Flexible Couplings.** Couplings shall meet the requirements of AWWA C219. Joint harnesses—if shown on the plans or specified in the special specifications—shall be in accordance with AWWA M11.

Center sleeves may be manufactured from carbon steel, stainless steel, or ductile iron, unless otherwise specified on the plans, special specifications, or as directed by the Engineer.

Bolts and washers for couplings shall be manufactured of type 316 stainless steel, and nuts shall be manufactured of type 316 stainless steel with a Xylan coating or approved equal. No anti-seize compound shall be applied on flanged bolts.

Nuts and bolts for couplings 2 inches in diameter and smaller shall be stainless steel or cadmium plated. Nuts and bolts for couplings larger than 2 inches in diameter shall be stainless steel 18-8 type 303.

The minimum working pressure of the coupling shall be the same as the working pressure of the pipeline to which the coupling is to be installed.

Interior and exterior coatings shall be applied by the manufacturer in accordance with AWWA C550 unless otherwise specified on the plans or in the special specifications. The minimum dry coating thickness shall be 12 millimeters unless the lining thickness is limited by the working tolerance of the coupling components.

(C) **Gaskets.** All gaskets must be full faced and NSF 61 approved. Gaskets must be at least 1/8 inch thick unless otherwise noted. Material for gaskets shall be SBR, Neoprene, NBR (BunaN), or EPDM rubber. All gaskets shall conform to ANSI/AWWA C111/A21.11, ANSI A21.10, ANSI A21.15, ASME B16.1 Class 125, and AWWA C207. Flange

connections shall be made without any strain or bending on the flanges. Flanged fittings shall be properly anchored and supported to prevent any damage to the flange or gasket. Any kind of adhesion chemical/lubricant will not be accepted during installation of the gasket; any gasket with adhesion will be rejected and replaced by the Contractor at no cost to GCEC. Segment gaskets are not allowed.

(D) **Repair Clamps**. When approved, repair clamps shall meet the following minimum specifications:

1) Repair clamps 2 inches and larger shall be of the full circle type.
2) Repair clamps smaller than 2 inches may have ductile iron or malleable iron lugs that shall be epoxy coated in accordance with AWWA C550.
3) All repair clamp components shall be constructed of type 316 stainless steel. The gasket shall consist of gridded rubber material with tapered ends suitable for the liquid in the pipeline.

EXECUTION

Installation.

General. Fittings, flexible couplings, gaskets, and repair clamps shall be installed in accordance with the manufacturer's recommendations and AWWA C600, except as modified herein.

All fittings, valves, flexible couplings, and repair clamps to be buried shall be encased with an 8-millimeter polyethylene wrap in accordance with AWWA C105, Method C.

Workmanship. The Contractor shall provide personnel skilled and knowledgeable regarding installation procedures for the fittings, flexible couplings, and repair clamps, as well as all incidental appurtenances being installed.

BACKFLOW

GENERAL

Description of work. The work under this Section shall consist of furnishing all labor, materials, tools, equipment, and incidental items required for the installation of fittings, flexible couplings, and repair clamps in accordance with the details shown on the plans and the requirements of these specifications.

Submittals. In order to be accepted for incorporation into the work, the manufacturer's make, model, and type of backflow device shall appear on the GCEC-approved materials list in these standard specifications.

Delivery, Storage, and Handling. All backflow devices shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as may be modified by the plans, special specifications, or as directed by the Engineer.

Materials

Backflow preventers shall be provided with pipe supports and the accessories necessary to properly secure the assembly. Backflow preventers shall be assembled with pipe, fittings, and risers of material approved by GCEC.

The backflow preventer assembly shall consist of pressure type or reduced pressure type backflow preventer unit and associated components conforming to the governing code requirements and as shown on the plans and specifications for installation.

Workmanship. The Contractor shall provide personnel skilled and knowledgeable regarding installation procedures for the pressure type or a reduced pressure units as well as all incidental appurtenances being installed.

TRAFFIC CONTROL

DESCRIPTION:

Traffic control shall consist of traffic control devices and flagmen and/or pilot cars. All traffic control devices, the application of traffic control measures, and traffic regulation in these specifications are intended to supplement and shall not delete any requirements of the applicable traffic barricade manual, the Manual on Uniform Traffic Control Devices, or applicable jurisdictional supplements to these specifications.

Traffic control is defined as the use of devices and services (flag persons and uniformed officers) when authorized to safely and efficiently move vehicular and pedestrian traffic through the construction zone and to protect workers from damage to person and property resulting from traffic movement through the construction zone.

Traffic control includes but is not necessarily limited to channelization of traffic approaching the construction zone; the installation, use, and maintenance of detours; the definition and illumination of vehicular and pedestrian ways; transitions beyond the construction zone; and the protection of workers from damage to their person and property, resulting from traffic movement through the construction zone.

Traffic control includes the protection of excavations during the period of actual work in the excavation and for a reasonable time (usually one work day) after the completion of the work for the purpose of backfilling the excavation.

The contractor shall provide for the adequate protection of all vehicular and pedestrian traffic and workers, through any portion of the work where construction operations interfere with, obstruct, or create a hazard to the normal movement of traffic.

All traffic control devices shall be kept clean and free from dirt, mud, and roadway grime. Scratches, rips and tears in reflective sheeting, or loss of fluorescence in fluorescent prismatic sheeting, as determined by the Engineer, shall be promptly corrected by the contractor.

Traffic shall be maintained over a reasonably smooth and safe traveled way which shall be so marked by signs, delineators, guiding devices, and other methods that a person who has no knowledge of conditions may safely and with a minimum of discomfort and inconvenience ride, drive or walk, day or night, over all or any portion of the highway and/or structure under construction where traffic is to be maintained. If shown on the project plans or otherwise noted in the specifications the traveled way shall be paved.

The contractor shall at all times conduct operations in a manner to insure the convenience of all travelers and the abutting property owners and their safety as well as the safety of all construction personnel.

Such conduct shall include, but not be limited to, insuring: that all construction materials and equipment are removed from the work site during non-working hours, or are protected in such

manner that they shall not constitute a traffic hazard; that shoulder construction and paving operations shall be conducted in such a manner as to minimize the period of time the traveling public is exposed to sharp drop-offs; and that workers shall not park personal vehicles in areas that hinder the movement of traffic or pedestrians or obstruct sight distance.

Traffic Control Plan. When a traffic control plan is included in the project plans, this plan shall govern unless an alternate plan, acceptable to the Engineer is submitted by the contractor. If no traffic control plan is provided, or, if the contractor desires to deviate from the provision for maintaining traffic as described in the project plans, the contractor shall submit a traffic control plan to the Engineer, for approval. The contractor's traffic control plan shall provide a proposed sequence of operations and a compatible method for maintaining traffic. The traffic control plan shall also address the contractor's proposed scheduling of the work, including, phasing, detours, signing, removal and application of pavement markings, flagging procedures, methods of delineation and channelization, periodic surveillance for required maintenance and inspection of traffic control devices.

A contractor-prepared traffic control plan shall be submitted to the Engineer early enough to allow at least two weeks for review and approval prior to commencement of any work on any project site. The traffic control plans shall be submitted on paper that can be reproduced on a copier or scanner (paper size for copier prints shall be not less than 8-1/2 inches x 11 inches nor more than 11 inches x 17 inches).

The traffic control plan of the contractor, along with the contractor's work schedule and actual operations, shall be such that no condition that is considered to be unsafe, in the opinion of the Engineer or Company Representative, shall exist. The traffic control plan shall ensure that miscellaneous operations occurring throughout the work, as well as during the final stages, are adequately protected. As a result of effective planning and efficient scheduling of the type and quantity of work, the duration, degree, length, amount, size, etc., of any traffic restriction or lane closures shall be limited to that absolutely necessary to provide a safe condition for both traffic and construction personnel.

All detours, partial closing, or other traffic alterations shall be approved by the Engineer. The traffic control plan shall also be submitted to the agencies having police and fire responsibility within the project site.

Traffic control/lane closures shall be in accordance with all applicable codes and ordinances. Unless otherwise noted in the Special Provisions or modified by the approved traffic control plan, the following shall apply:

Unless otherwise specified in the Special Provisions, arterial or collector street lane reductions shall not exist between 7-9 AM and 4-6 PM, Monday-Friday.

The contractor shall provide a uniformed off-duty police officer to direct traffic as required.

The contractor is responsible for the proper installation and inspection of all traffic control devices within the limits of the project.

The contractor shall ensure that existing traffic signs and signals are properly maintained, operated, removed, stored or installed.

All traffic signs that are not in use or traffic and/or pedestrian signals that are not operating due to the contractor's work shall be either turned away from traffic or covered with a purpose-fabricated, cover acceptable to the Engineer or Company Representative.

With the exception of emergencies, the contractor shall obtain the approval of the Engineer or Company Representative, a minimum of two days in advance of the closure or restriction of any street or public right-of-way.

Street closures or restrictions shall conform to the approved traffic control plan.

Materials, vehicles, and parked equipment shall be kept as far from the traveled way as practical. The Contractor shall not park vehicles or equipment, or store materials within 10 feet of the edge of a traveled way unless otherwise approved by the Engineer or Company Representative.

Any devices provided under this Section which are lost, stolen, destroyed or deemed unacceptable by the Engineer or Company Representative while their use is required on the project shall be replaced by the Contractor at no additional cost to GCEC.

Traffic control signs and delineators not permanently installed shall be weighted down. Furnishing and replacement of lost or damaged sand bags or flags shall be the responsibility of the contractor. The Engineer shall determine which signs may require portable stands or embedded posts.

All traffic control devices necessary for the first stage of construction shall be properly placed and in operation before any construction is allowed to start. When work of a progressive nature is involved, such as resurfacing a road under traffic, the necessary devices shall be moved concurrently with the advancing operation.

If shown on the project plans or required in the proposal, the contractor shall provide a paved traveled way suitable for two lanes or more of moving traffic. The traveled way shall be kept reasonably smooth and hard at all times, and shall be well drained and free of potholes, bumps, irregularities, and depressions that hold or retain water. Construction operations shall be conducted to insure a minimum of delay to traffic. Stopping traffic for more than five minutes shall not be permitted unless specifically authorized by the Engineer or Company Representative. The necessary equipment and personnel to attain and maintain a satisfactory riding surface shall be available and used as needed at all times when work is under way and when work is temporarily suspended for any period of time. Special attention to maintenance of a satisfactory traveled way shall be given during nights, weekends, and holidays.

Basic Maintenance and Protection of Traffic. Basic maintenance and protection of traffic shall consist of all work to prepare and obtain approval of the traffic control plan,

coordination for flagging services, furnishing, installing, maintaining, moving and removing, barricades, warning signs, lights, cones, installation of temporary pavement markings for the contractor's sequencing and phasing of the work, removal of existing pavement markings and raised pavement markers by obliteration, covering of existing signs and other traffic control elements as specified in this Subsection.

A. **Cleaning of Roadways and Sidewalks.** The contractor shall keep the sidewalk and traveled way free of foreign objects such as spilled earth, rock, timber, and other items that may fall from transporting vehicles. Material spilled by or dropped from the undercarriage of any carrying vehicle used in the contractor's hauling operations along or across any public sidewalk or traveled way both within and outside the contract limits shall be removed immediately.
B. **Dust Control.** Dusty conditions resulting from either the contractor's operations or vehicular traffic using the roadway shall be corrected. Water used as a dust palliative, shall be distributed uniformly by the use of suitable spray heads or spray bar.
C. **Drainage.** The contractor shall devote particular attention to all drainage facilities, keeping them fully operative at all times. Ditches shall be provided at all times, even during grading operations, to adequately drain the traveled way including detours and the remainder of the right-of-way areas.
D. **Ingress and Egress**. The contractor shall provide and maintain, at all times, safe and adequate ingress and egress, for both vehicular and pedestrian traffic, to and from intersecting roadways, homes, businesses, commercial establishments and at existing or at new access points, consistent with the work, unless otherwise authorized by the Engineer or Company Representative. On roadways on which bus service is maintained, the contractor shall provide suitable areas or locations for the loading and unloading of passengers. The contractor shall coordinate with utilities to ensure access to their facilities, as required, throughout the construction period. The existing pavement, at improved intersecting streets, shall not be disturbed without prior consent of the Engineer or Company Representative. Should it become impossible or impractical to maintain access to a business or residence, the contractor shall notify the affected business or property owner a minimum of 24 hours in advance of the disruption of access. Access shall be restored as soon as possible and, in no case shall access be denied for more than eight hours.
E. **Repairs.** The contractor shall make the necessary repairs to existing pavement, detours, structure wearing surfaces and other roadway elements as required to provide a reasonably smooth and safe traveled way where vehicle operation or pedestrian traffic is maintained.
F. **Schedule.** The contractor shall schedule the work to keep to a minimum, and consistent with the contract documents, the amount of existing pavement and/or facilities that are rendered unusable or obliterated at any one time. Unless otherwise indicated on the project plans or in the contract documents or approved by the

Engineer or Company Representative, the length of existing facility rendered unusable or obliterated shall not exceed 1 mile.

G. **Responsibility to the Public.** The contractor shall protect the public from damage to person and property which may result directly or indirectly from any construction operation. The contractor shall notify all appropriate emergency service providers including police, fire and ambulance departments, of the impending construction two weeks prior to the start of work. This notification shall also be made to the U.S. Postal Service, school district(s) and public transit authorities as well as property owners and businesses adjacent to the project. Emergency vehicles and school buses will be given priority status in traversing the construction zone. Access to police, fire and ambulance facilities as well as fire hydrants and hospitals shall be maintained at all times. Auxiliary flashing lights may be required on work vehicles exposed to traffic. Shadow vehicles, equipped with appropriate signs, flags, flashing lights, and/or attenuation devices may be required to protect mobile equipment and moving operations. Local access shall be maintained to all properties on the project at all possible times. When local access cannot be maintained, the Contractor must notify the affected property owner at least 24 hours in advance and restore access as soon as possible. The Contractor shall provide and maintain all necessary traffic controls to protect and guide traffic for all work in the construction area. The Contractor shall maintain all existing STOP, YIELD, and street name signs erect, clean, and in full view of the intended traffic at all times. If these signs interfere with construction, the Contractor shall temporarily relocate the signs away from construction but still in full view of the intended traffic.

H. **Railroad Protection**. Where the contract work effects railroad companies, the maintenance and protection of traffic.

I. **Duration of Contract.** The duration of the contract, for the purpose of this work, shall be from the date any work is started on the contract, including moving in equipment, signs, offices, shops, and the like, until the date the project is officially accepted.

J. Existing Signs.

a. **Control and Authority.** All existing roadway signs, markers, delineators and their supports, authorized by the Agency, within the contract limits shall remain under the control and jurisdiction of the Engineer or Company Representative and shall be maintained for the duration of the contract by the contractor as directed by the Engineer or Company Representative. Any signs not authorized by the Agency shall be removed from the right-of-way as ordered by the Engineer or Company Representative. The contractor shall maintain all existing stop, yield, and street name signs erect, clean, and in full view of the intended traffic at all times. If these signs interfere with construction, the contractor shall temporarily relocate the signs away from

construction but still in full view of the intended traffic. The maintenance needs associated with stop or yield signs shall require the immediate attention and singular priority of the contractor throughout the construction period. Existing traffic signs other than stop, yield, and street name signs shall be maintained by the contractor until such time as construction renders them obsolete. At that time, the contractor shall remove signs and posts without damage and deliver them as directed by the Engineer or Company Representative.

b. **Storage and Existing Signs, Markers and Delineators.** The contractor, when ordered, shall remove existing signs, markers and delineators and their supports which interfere with construction operations; store, protect, clean, and replace them, as directed, and in a location approved, by the Engineer or Company Representative. Signs, markers, and delineators not to be replaced, shall be cleaned and delivered to the Engineer as directed. Signs, markers and delineators lost or damaged because of negligence on the part of the contractor, shall be replaced at no additional cost to the Agency.

Delineation and Guiding Devices for Construction. The contractor shall furnish, erect, move, and remove delineation and guiding devices as required and directed by the Engineer or Company Representative. In areas where grading is being done, a safe and reasonable roadway shall be properly delineated at all times, either by the use of guiding devices or flaggers. The contractor shall delineate areas where there is a drop-off near the edge of the traveled way and areas on which it is unsafe to travel. The contractor shall furnish, install, move, and remove orange safety fence anytime that pedestrian traffic is adjacent to an open excavation or as otherwise directed by the Engineer or Company Representative.

Flagging Services. Whenever it becomes necessary to maintain traffic on one lane, the contractor shall provide adequate traffic controls on the section of roadway on which vehicle operation is maintained. The contractor shall employ a sufficient number of certified flaggers to control one-lane traffic continuously. The contractor shall furnish verification to the Engineer or Company Representative that all civilian flaggers have completed a recognized training and certification program. Flaggers certified by the American Traffic Safety Services Association (ATSSA) or by the National Safety Council shall be acceptable. Certification through other programs offering flagger training must be approved by the Engineer or Company Representative. Flagger certification must be current. Training and certification shall be required at least once every two years.

In the event the length of the one lane operation is extremely short and conditions are favorable for safe operation, the Engineer or Company Representative may, in writing, authorize the contractor to dispense with flaggers. The contractor shall also provide a sufficient number of competent flaggers in areas where construction equipment is operating in potential conflict with public traffic, regardless of the volume of traffic or the sight distance. Flaggers, other than a uniformed, off-duty law enforcement officer, shall wear Hi-Vis vests and hard hats in conformance with current standards and shall direct traffic in conformance with said standards. Uniformed off-duty law enforcement officers may be required to wear a safety vest, approved by their department and as directed by the Engineer or Company Representative.

Provide Detour. When the contract provides for the construction of detours, such detours, including any temporary drainage structures, base and surfacing materials, and accessory features, shall be constructed to the lines and grades established. When the use of a detour is no longer required, any temporary structures and accessory features shall be removed and disposed of and the detour roadways shall be removed and the ground shall be restored, as nearly as practicable, to the condition existing prior to the construction of the detour. When specific details are not indicated on the project plans or when a detour is proposed by the contractor, the contractor shall provide all elements of the detour including all warranted safety features. The proposal shall be done in accordance with the following guidelines: Guidelines regarding horizontal and vertical alignment shall be shown. The posted speed limit for the detour shall be determined by the Agency Traffic Engineer or the Traffic Engineer's agent. The detour shall be paved, or stabilized as approved by the Engineer, and shall provide as a minimum two, 10-foot lanes, one for each direction of travel. Prior to beginning construction of any detour proposed by the contractor, subcontractor, or agent, the contractor shall submit details to the Agency, through the Engineer, for review and approval. Such review, however, shall not relieve the contractor of the responsibility for the adequacy of such detour. Detours shall be constructed in a manner and sequence such that interference with and inconvenience to the traveling public and abutting property owners is kept to a minimum. The contractor shall be responsible for the materials, workmanship, maintenance and safety of all detours.

PROTECTION OF EXISTING UTILITIES:

Utilities: Unless otherwise shown on the plans or stated in the specifications, all utilities, either underground or overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

If the Contractor desires to simplify his operation by temporarily or permanently relocating or shutting down any utility or appurtenance, he shall make the necessary arrangements and agreements with the owner and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. All property shall be reconstructed in its original or new location as soon as possible and to a condition at least as good as its previous condition. This cycle of relocation or shutdown and reconstruction shall be subject to inspection and approval by both the Engineer and the owner of the utility.

The Contractor shall be entirely responsible for safeguarding and maintaining all conflicting utilities that are shown on the plans. This includes overhead wires and cables and their supporting poles whether they are inside or outside of the open trench. If, in the course of work, a conflicting utility line that was not shown on the plans is discovered, the Contracting Agency will either negotiate with the owner for relocation, relocate the utility, change the alignment and grade of the trench or as a last resort, declare the conflict as "extra work" to be accomplished by the Contractor.

Backfill, around utilities that are exposed during trench excavation, shall be placed in accordance with the utility's haunching and initial backfill requirements.

At points where the Contractor's operations are adjacent to properties of utility firms or other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not commence until all arrangements necessary for the protection thereof have been made. The Contractor shall cooperate with the owners of any underground or overhead utilities in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

If any utility service is interrupted as a result of accidental breakage, the Contractor shall promptly notify the proper authority and shall cooperate with the said authority in the restoration of service. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority. The Contractor shall expose all underground utilities and structures, which might interfere with the construction of the project, in order to permit survey location prior to construction.

The Contractor shall assume full responsibility for damages to any underground facility/utility as a result of failing to obtain information as to its location, failing to excavate in a careful and prudent manner or failing to take measures for protection of the facilities/utilities. The Contractor is liable to the owner of the underground facility/utility for the total cost of the repair.

Irrigation Ditches, Pipes and Structures: The Contractor shall contact the owners of all irrigation facilities and make arrangements for necessary construction clearances and/or dry-up periods.

All irrigation ditches, dikes, headgates, pipe, valves, checks, etc., damaged or removed by the Contractor, shall be restored to their original condition or better, by the Contractor at no additional cost to the Contracting Agency.

Building Foundations and Structures: Where trenches are located adjacent to building foundations and structures, the Contractor shall take all necessary precautions against damage to them. The Contractor shall be liable for any damage caused by the construction.

Except where authorized in the special provisions or in writing by the Engineer, water settling of backfill material in trenches adjacent to structures will not be permitted.

Permanent Pipe Supports: Permanent pipe supports for the various types and sizes of sewer, water and utility lines shall conform to the Standard Details or the details shown on the plans. Such pipe supports shall be erected at the locations shown on the plans and/or at any other location as necessary as determined by the Engineer.

FOUNDATION, BEDDING, HAUNCHING, BACKFILLING AND COMPACTION:

Foundation: The bottom of an excavation upon which a structure is to be placed or the bottom of a trench where the elevation is set below the pipe elevation shown on the plans or as directed by the Engineer. The elevation of the trench foundation is determined from the desired pipe elevation by taking into account the bedding and pipe wall thicknesses. The foundation surface will consist of native material or replacement material required due to over-excavation.

Bedding: Bedding is the material upon which a pipe is to be placed.
The bedding material type shall be ABC unless otherwise specified.

Haunching: Haunching is the material placed between the bedding and spring line. If placed in lifts, the lift thickness shall not exceed 2 feet (1 foot for flexible pipe) and shall be deposited and compacted to the specified density uniformly on each side of the pipe to prevent lateral displacement of the pipe.

The haunching material shall be ABC. With Agency approval, an alternative granular material or CLSM may be used.

Initial Backfill: The material placed between the spring line to 12 inches above top of pipe. Initial backfill shall be placed in lifts that shall not exceed 2 feet (1 foot for flexible pipe) and which can be effectively compacted depending on the type of material, type of equipment, and methods used.

Initial backfill material shall be ABC. With Agency approval, an alternative granular material or CLSM may be used, and with agency approval, native backfill with no piece larger than 1½ inches may be used for concrete pipe.

Final Backfill: Material placed above the initial backfill to the top of the trench or to the bottom of the road base material. Final backfill shall be placed in horizontal layers not more than twelve inches in depth before compaction. With Agency approval, an increase in the loose non-compacted lift depth may be obtained for a project based on specific equipment, methods, and soil conditions. For approval of an increase of the non-compacted lift depth the Contractor shall demonstrate to the satisfaction of the Agency that the required density will be obtained using the Contractor identified equipment and methods. The non-compacted lift height shall not be more than can be compacted to the required density with the equipment and methods being used.

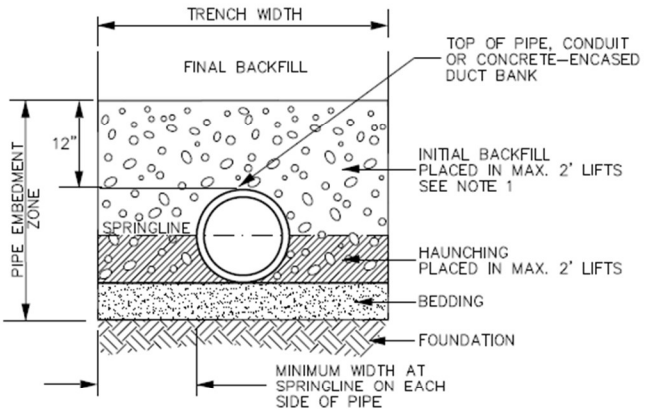
Final backfill shall be CLSM, ABC, and/or granular material or native backfill material.

Backfill under street pavement shall be constructed with the type of trench and surface replacement as noted on the plans or in the special provisions. Unless otherwise noted, backfill under single curb, curb and gutter, attached sidewalk, driveways, valley gutters, etc. shall be the same as the adjacent street pavement.

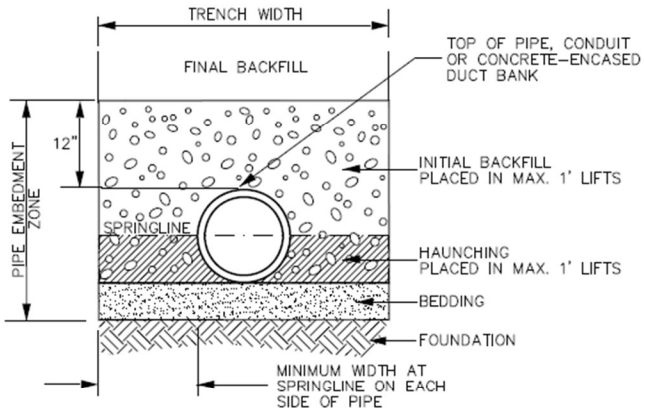
Compaction Densities: Trench backfill shall be thoroughly compacted to not less than the densities shown when tested and determined by AASHTO T-99 and T-191 or ASTM D6938. When AASHTO T-99, method A or B, and T-191 are used for density determination, AASHTO T99 Annex A shall be used for rock correction.

Bedding, haunching and initial backfill material, as defined from Detail 200-2, shall be processed prior or while being placed, and then compacted to obtain the required optimum moisture content within +/- 3 percentage points when tested in place.

At the discretion of the Engineer, mechanically excavating test pits to expose previously compacted lifts where documentation is not available may be allowed. Test pit locations and depths for the compaction testing shall be selected by the Engineer or designated geotechnical representative. No hydro-excavating of test pits shall be allowed. Excavation of test pits shall be done during full time observations by the Engineer or designated geotechnical representative. Once compaction tests have been taken, the Contractor shall backfill and re-compact the test pits. Excavating, backfilling and compacting test pits shall be at Contractor's expense.
When backfill material is CLSM and it is placed, no compaction testing is required, the compaction density shall be deemed acceptable.



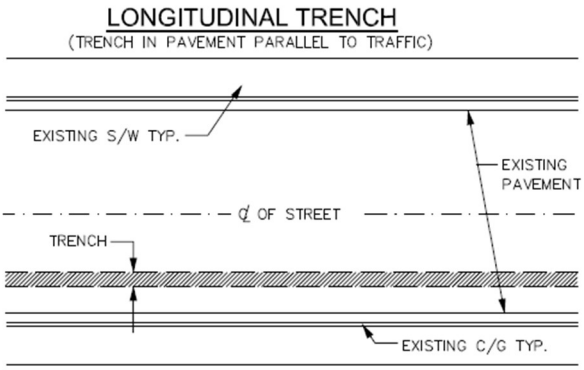
TRENCH-CROSS SECTION DETAIL
RIGID PIPE

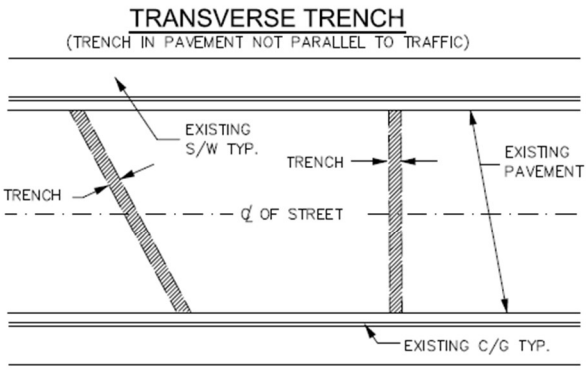


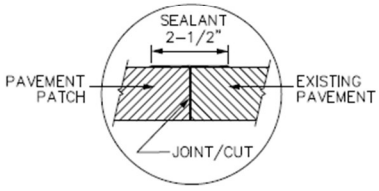
TRENCH-CROSS SECTION DETAIL
FLEXIBLE PIPE

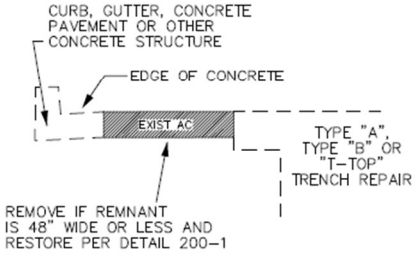
Notes:

1. **Bedding, Haunching and initial backfill material shall be ABC per fill construction and alternative materials to be used with agency approval.**
2. **See trenching Section for additional trench width, excavation, backfilling and compaction requirements.**
3. **See Pipe section for materials considered as rigid or flexible.**
4. **Pipe materials that are considered to be rigid include reinforced concrete pipe, non-reinforced concrete pipe, reinforced concrete cylinder pipe, vitrified clay pipe, steel casings, cast iron, and ductile iron pipe.**
5. **Pipe materials that are considered to be flexible include thermoplastic pipes (HDPE, SRPE, PP, PVC), corrugated metal pipe, and thermoset pipes such as Fiberglass Reinforced Polymer Mortar (FRPM) pipe**



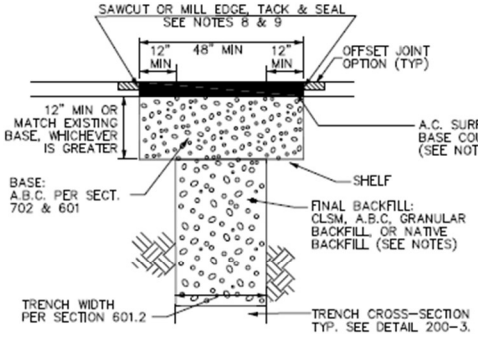






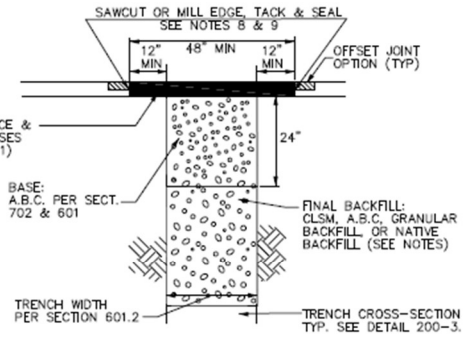
Notes:

1. **Trench excavation, backfilling and compaction requirements per backfilling specifications.**
2. **See requirements for fill construction section regarding the use of plating transverse trenches. Use of steel plates shall not exceed 72 hours after completion of backfill and prior to final patching.**



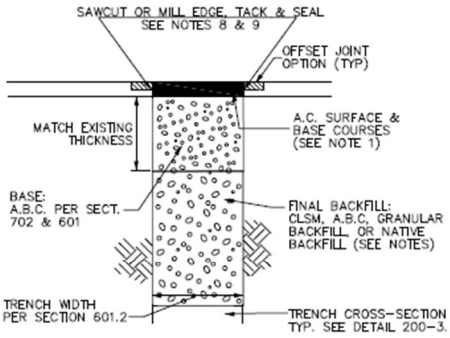
"T TOP" TRENCH REPAIR

(USE FOR TRANSVERSE TRENCH REPAIRS, SEE DETAIL 200–2)



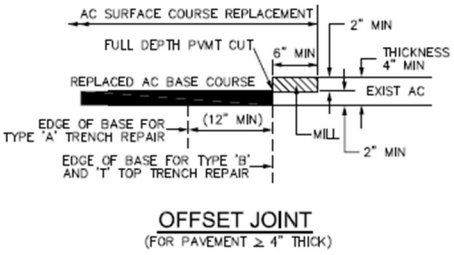
TYPE "A" TRENCH REPAIR

(USE FOR LONGITUDINAL TRENCH REPAIRS, SEE DETAIL 200–2)



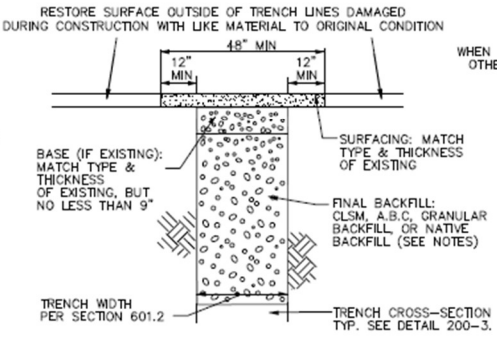
TYPE "B" TRENCH REPAIR

(USE FOR TRANSVERSE TRENCH REPAIRS IF SPECIFIED BY AGENCY)



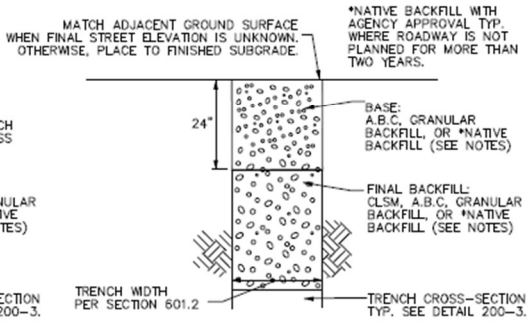
OFFSET JOINT

(FOR PAVEMENT ≥ 4" THICK)



TYPE "D" TRENCH REPAIR

(TRENCH NOT UNDER CONCRETE OR ASPHALT PAVEMENT)



TYPE "E" TRENCH REPAIR

(TRENCH IN FUTURE ROADWAY PRISM OR ALLEY)

NOTES:

Notes:

1. **Pavement matching, base course and surface replacement shall be in accordance with backfill section unless otherwise specified in contract documents.**
2. **Trench excavation, backfilling and compaction shall be in accordance with trenching section. Native backfills shall only be used with company approval.**
3. **CLSM shall be ½-sack or 1-sack**
4. **Material for final backfill and base shall be as noted herein unless otherwise specified in contract documents.**

FILL CONSTRUCTION

DESCRIPTION:
Fill construction shall consist of constructing embankments except as may otherwise be specified, including the preparation of the areas upon which they are to be placed; the construction of dikes; the placing and compacting of approved material within areas where unsuitable material has been removed; and the placing and compacting of material in holes, pits, and other depressions.

Unless otherwise specified in the special provisions, material obtained from the project excavations may be presumed to be suitable for use as fill or backfill provided that all organic material, rubbish, debris, and other objectionable material is first removed. However, stone, broken Portland cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the backfill.

Unless otherwise specified in the special provisions, the density of fills and backfills shall be at least 90 percent.

PLACING:
Rocks, broken concrete, or other solid material, which are larger than 4 inches in greatest dimension, shall not be placed in fill areas where piles are to be placed or driven.
When fill is to be made and compacted on hillsides or where new fill is to be compacted against existing fill or where embankment is built one half width at a time, the slopes of original hillsides and old or new fills shall be benched a minimum of 4 feet horizontally as the fill is placed. A new bench shall be started wherever the vertical cut of the next lower bench intersects the existing ground. Material thus cut out shall be recompacted along with the new embankment material by the Contractor at no additional cost to the Contracting Agency, unless the width of the bench required exceeds 4 feet, in which case the excavated material in excess of 4 feet will be measured and paid for as excavation.
Clods or hard lumps of earth of 6 inches in greatest dimension shall be broken up before compacting the material in embankment, except as provided in the following paragraph:
When the fill material includes large rocky material, or hard lumps, such as hardpan or cemented gravel, which cannot be broken readily, such material, shall be well distributed throughout the fill. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact fill. However, such material shall not be placed within 2 feet of the finished grade of the fill.

COMPACTING:
Fill shall be constructed in compacted layers of uniform thickness and each layer shall be compacted in accordance with the requirements herein specified with the following exception. Where fills are to be constructed across low, swampy ground which will not support the weight of hauling equipment, the lower part of the embankment may be constructed by dumping successive loads of suitable materials in a uniformly distributed layer of thickness not greater than that necessary to support the equipment while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

Unless specified herein, or in the special provisions, the construction of dikes, the placing and compacting of approved material within the right-of-way where unsuitable material has been removed, and the filling of holes, pits and other depressions within the right-of-way, shall conform to all of the requirements herein specified for compacting fills. Trenches, holes, depressions and pits outside of areas where fills are to be constructed shall be graded to provide a presentable and well-drained area.
Areas over which fills are to be placed shall be cleared and scarified to a depth of 6 inches to provide a bond between the existing ground and the material to be deposited thereon. Unless otherwise specified, the original ground area upon which fills are to be constructed shall be compacted to a uniform density of not less than 95 percent.
The loose thickness of each layer of fill material before compacting shall not exceed 8 inches, except as provided in the following paragraph for rocky material. Each layer shall be compacted in accordance with the following requirements to a uniform density of not less than 90 percent, except that where a new or widened roadway and appurtenances are required, density of the upper 2 feet and when the fill is within 2 feet of the above shall be not less than 95 percent.

When fill material contains by volume over 25 percent of rock larger than 6 inches in greatest dimension, the fill below a plane 3 feet below finished grade may be constructed in layers of a loose thickness before compaction not exceeding the maximum size of rock in the material but not exceeding 3 feet in thickness.
The interstices around the rock in each layer shall be filled with earth or other fine material and compacted. Broken Portland cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the fill with the following limitation:

(A) The maximum dimension of any piece used shall be 6 inches.
(B) Pieces larger than 4 inches shall not be placed within 12 inches of any structure.
(C) Pieces larger than 2 ½ inches shall not be placed within 12 inches of the subgrade for paving.
(D) Nesting of pieces will not be permitted.

At the time of compaction, the moisture content of fill material shall be such that the specified relative compaction will be obtained and the fill be firm and unyielding. Fill material, which contains excessive moisture, shall not be compacted until the material is dry enough to obtain the required relative compaction. Full compensation for any additional work involved in drying fill material to the required moisture content shall be considered as included in the contract price paid and no additional compensation will be allowed therefore.

Embankments shall be constructed so that each layer shall have a cross fall of at least 2 percent but no more than 5 percent.

TESTS:
Unless otherwise provided in the plans or special provisions the fill shall be thoroughly compacted to not less than the stated densities when tested and determined by AASHTO T-99, Method A, and T-191 or ASTM D6938 with the percent of density adjusted in accordance with the rock correction procedure for maximum density determination, standard detail, to compensate

Blocking and Restraints: All pipe lines, valves and fittings 16 inches and smaller in diameter shall be blocked with concrete thrust blocks in accordance with standard details. Thrust block areas for pipe, valves and fittings larger than 16 inches in diameter shall be installed per details shown on the plans. The areas stipulated in the standard details are minimums and shall not be decreased.

If irregular soil or pressure conditions are encountered, a thrust block design revision or an alternate joint restraint system may be required by the Engineer.

When restrained/welded joints are specified to resist thrust forces, blocking is not required.

With the Engineers approval, restrained/welded joints may be used in lieu of thrust blocks.

Where restrained joints are specified on mains sixteen (16) inches in diameter and smaller, ductile iron pipe shall be used with an approved joint restraint method.

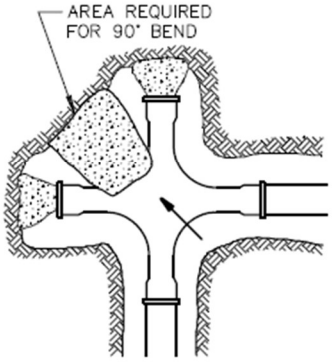
MEASUREMENT:
The quantities of fill construction used to construct embankments or dikes will be those of the complete bid item, in place, within the limits of dimensions shown on the plans.

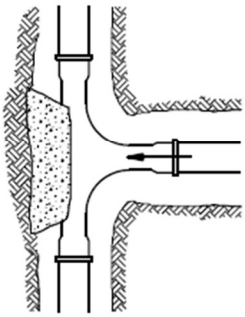
The Engineer will compute the quantities of fill by a method, which in his opinion is best suited to obtain an accurate determination. for the rock content larger than that which will pass a No. 4 sieve.

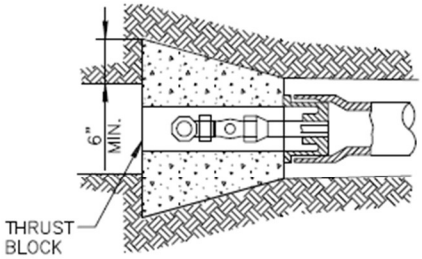
PAYMENT:
Quantities of fill construction will be paid for at the contract unit price per cubic yard of fill as stipulated in the proposal. Such price shall include placing and compaction and all related work as specified above, unless an alternate basis of payment is stipulated in the proposal.

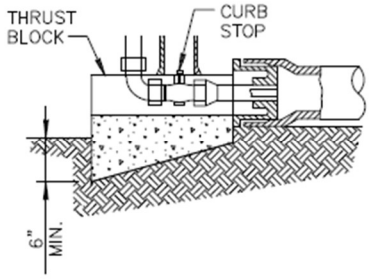
Unless otherwise provided in the special provisions, no payment will be made for fill construction to replace unsuitable material or for fill for holes, pits, and other depressions. The cost thereof shall be included in the price bid for the construction of the items to which such fill is incidental or appurtenant.

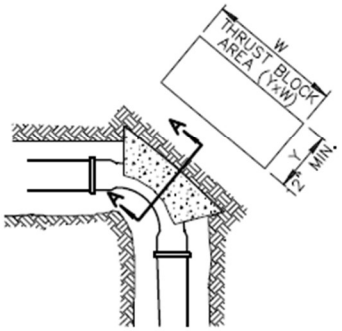
TYPICAL LOCATIONS OF THRUST BLOCKS

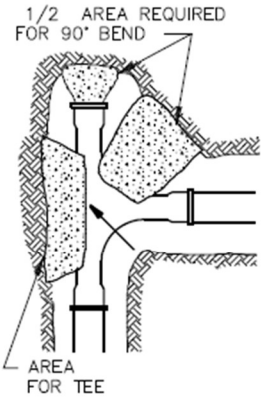


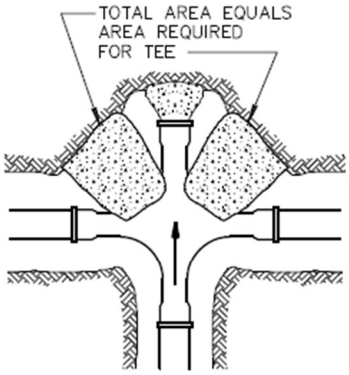


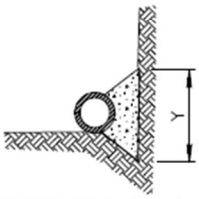












SECTION A–A

NOTES:

1. TABLE IS BASED ON 200 P.S.I. TEST PRESSURE AND 3,000 LBS/SQ FT. SOIL. IF CONDITIONS ARE FOUND TO INDICATE SOIL BEARING IS LESS, THE AREAS SHALL BE INCREASED ACCORDINGLY.
2. AREAS FOR PIPES LARGER THAN 16" SHALL BE CALCULATED FOR EACH PROJECT.
3. FORM ALL NON–BEARING VERTICAL SURFACES.
4. THRUST BLOCKS ARE TO EXTEND TO UNDISTURBED GROUND. CONCRETE TO BE CLASS 'C', SECT. 725.

MINIMUM THRUST BLOCK AREA REQUIRED (YxW) (SQ. FT.)		
PIPE SIZE	WATER PIPE	
	TEE, DEAD END, 90° BEND	45° & 22 1/2° BENDS
4" OR LESS	3	3
6"	4	3
8"	6	3
10"	10	5
12"	14	7
16"	24	12

TAPPING SLEEVE AND VALVE

Description of Work. The work under this Section shall consist of furnishing all labor, materials, and equipment required for the installation of tapping sleeves and valves in accordance with the plans and requirements of these specifications.

Submittals. Tapping sleeves and valves and the materials used in their manufacture shall comply with the standards in Appendix B and appear on the Approved Materials List.

Delivery, Storage, and Handling. Tapping sleeves and valves shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions except as modified by the plans, special specifications, or as directed by the Engineer.

PRODUCTS

Materials.

Pressure Class. Design pressure for tapping valves shall be 200 pounds per square inch for diameters up to 12 inches, and 150 pounds per square inch for diameters 16 inches and larger. Valves for operating pressures other than the above shall be as specified on the plans or in the special specifications. Tapping sleeves shall be rated for a minimum working pressure of 150 pounds per square inch.

Tapping Sleeves and Valves. Tapping valves shall be identical in construction to resilient-seated gate valves as specified in Section 1410. Tapping valves shall have ends and seat rings of sufficient size to permit the use of full-size cutters.

Tapping sleeves are considered an integral part of a tapping valve assembly, with openings identical to those of the valve.

Tapping sleeves shall be ductile iron or stainless steel.

All tapping sleeves shall be factory lined and coated with a corrosion-resistant epoxy in accordance with ANSI/AWWA C550. Tapping sleeves shall be provided with a neoprene gasket and stainless steel bolts.

Size on size taps may be made no closer than 30 inches from a joint. All other taps must be minimum distance of 18 inches from a joint.

EXECUTION

Installation.

General. Tapping sleeves and valves shall be installed in accordance with manufacturer's recommendations. Size on size tapping for pipe 12 inches in diameter and larger will not be accepted.
All fittings, valves, flexible couplings, and repair clamps shall be encased with an 8-millimeter polyethylene wrap in accordance with AWWA C105, Method C.

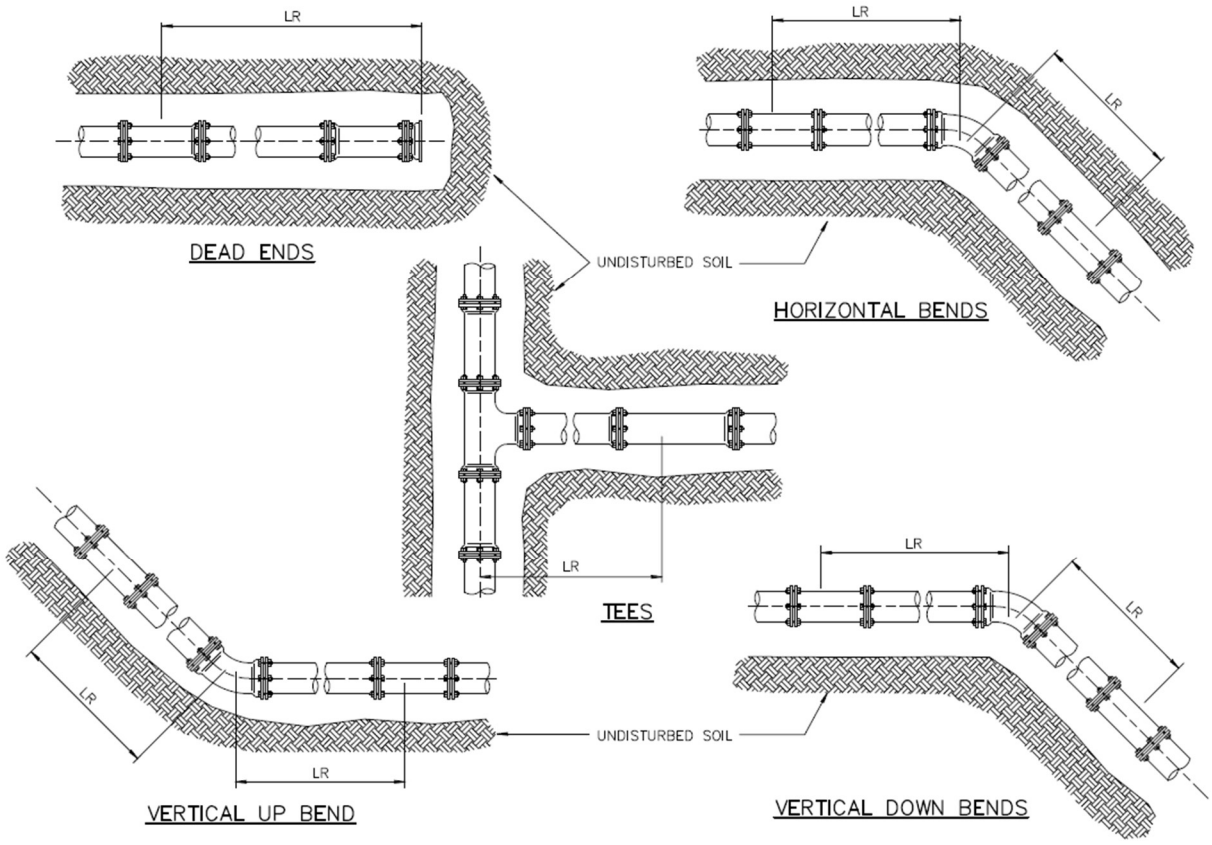
Workmanship. All the Contractor's, subcontractor's, or company's personnel shall be skilled and knowledgeable regarding installation procedures for the tapping sleeves and valves, as well as all incidental appurtenances being installed.

Valves. Prior to installation in the trench, valves 16 inches or larger shall be fully opened and closed by the Contractor or Company to check the operation and ensure the valve fully seats. A record shall be made of the number of turns required to fully open or close the valve. This record shall be included on the as-built plans. The inside of the valve shall be thoroughly cleaned prior to valve installation.

Tapping Valves. Tapping sleeves and tapping equipment shall be supported independently from the pipe during tapping operations.

Thrust Restraint. Thrust restraint for tapping sleeves and valves shall be in accordance with the requirements of this section.

Testing. Air testing is not allowed. All tapping sleeves shall be hydrostatically tested for 15 minutes to the working pressure of the main being tapped. Any visible leaks or pressure drop constitute failure.



LENGTHS RESTRAINED, LR, FOR DUCTILE IRON PIPE WITH POLYETHYLENE WRAP												
NOMINAL PIPE SIZE INCHES	HORIZONTAL BENDS				TEES	VERTICAL DOWN BENDS			VERTICAL UP BENDS			DEAD ENDS & VALVES
	11.25°	22.5°	45°	90°		22.5°	45°	90°	22.5°	45°	90°	
4	3	5	10	24	73	15	31	73	5	10	24	73
6	4	7	14	33	104	21	43	104	7	14	33	104
8	5	9	18	43	134	27	56	134	9	18	43	134
12	6	12	25	59	190	38	79	190	12	25	59	190
16	6	12	24	56	182	37	76	182	12	24	56	182
24	8	16	32	77	256	51	106	256	21	32	77	256

LENGTHS RESTRAINED, LR, FOR BARE DUCTILE IRON PIPE AND PVC PIPE												
NOMINAL PIPE SIZE INCHES	HORIZONTAL BENDS				TEES	VERTICAL DOWN BENDS			VERTICAL UP BENDS			DEAD ENDS & VALVES
	11.25°	22.5°	45°	90°		22.5°	45°	90°	22.5°	45°	90°	
4	2	5	9	21	57	12	24	51	5	9	21	57
6	3	6	12	29	80	16	33	73	6	12	29	80
8	4	8	16	38	105	21	44	94	8	16	38	105
12	6	11	22	52	148	30	62	133	11	22	52	148
16	5	10	21	50	143	29	59	128	10	21	50	143
24	7	14	29	68	201	40	84	179	18	29	68	201

NOTES:

1. LENGTHS RESTRAINED MAY BE REDUCED WITH SUPPORTING CALCULATIONS SEALED BY AN ARIZONA PROFESSIONAL ENGINEER.
2. WHEN CONNECTING TO EXISTING PIPELINES, IT CANNOT BE ASSUMED THAT EXISTING PIPELINES ARE RESTRAINED. ADDITIONAL RESTRAINT MEASURES SUCH AS BLOCKS OR ANCHORS MAY BE REQUIRED AND SUBJECT TO APPROVAL BY THE AGENCY.
3. IF PIPE SIZE IS NOT LISTED, MOVE TO THE NEXT LARGER PIPE SIZE IN THE TABLE.
4. ALL LENGTHS ARE IN FEET.
5. ALL JOINTS WITHIN THE SPECIFIED LENGTHS MUST BE RESTRAINED.
6. THE REQUIRED LENGTHS RESTRAINED MAY OVERLAP DUE TO THE LOCATION OF BENDS, TEES, AND DEAD ENDS. IN THESE SITUATIONS, RESTRAINED PIPE JOINTS MUST MEET THE LONGEST REQUIRED LENGTH RESTRAINED IN EACH DIRECTION, THROUGH THE OVERLAP SECTION.
7. ALL INLINE VALVES MUST BE TREATED AS DEAD ENDS.

ASSUMPTIONS:

1. THE TABLES FOR LENGTHS RESTRAINED ARE BASED ON THE EQUATIONS AND PROCEDURES FOUND IN THE DIPRA BROCHURE THRUST RESTRAINT DESIGNATION FOR DUCTILE IRON PIPE AND EBAA IRON RESTRAINT CALCULATOR. CONSERVATIVE ASSUMPTIONS HAVE BEEN EMPLOYED, ALONG WITH AN OVERALL SAFETY FACTOR OF 2.0. FOR ANY GIVEN PROJECT, THE ULTIMATE RESPONSIBILITY OF PROPER USE OF THIS TABLE RESTS WITH THE USER.
2. CALCULATIONS ARE BASED ON AWWA C150 TYPE 4 TRENCH AT A PIPE BURY DEPTH OF 3 FEET.
3. SOIL DESIGNATION IS GOOD SAND & GRAVEL. SW, SP, & GW OF THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS).
4. TEST PRESSURE IS ASSUMED AT 200 PSI FOR SIZES SMALLER THAN 16 INCHES AND 150 PSI FOR SIZES 16 INCHES AND LARGER.

APPENDIX A

DIP	American McWane US Pipe
DIP, Integral Restraint Systems	American • Fastite Flex-Ring • Lok-Ring McWane • Restrained Tyton • Thrust-Lock US Pipe • HP LOK • TR FLEX
PVC	Diamond JM Eagle North American
Gate Valves	Clow M & H Mueller US Pipe Waterous • AFC • AFC Alpha End
Tapping Sleeves, Epoxy Coated	Ford JCM PowerSeal Romac
Tapping Sleeves, Stainless Steel (Flange Branch only)	Ford JCM PowerSeal Romac
Ductile Iron Fittings	SIGMA SIP Industries Star Pipe Tyler/Union
Ductile Iron Compact Fittings	SIGMA Star Pipe Tyler/Union

Transition Coupling	Ford – FC2A JCM – 201 PowerSeal – 3501 Romac • 501 • Alpha
Wide Range Coupling	Romac • Alpha • Macro Ford- FC2W, FC3
Repair Clamps (Stainless Steel wraparound)	Ford – FS1 JCM – Model 101 PowerSeal – 3121 AS Romac • SS1 • SS2 • SS3
Combination Air Release Valves, 3/4 to 6”	Ames Bermad Cla-Val Watts Wilkins
Pipe Restraints, Ductile Iron and PVC	Ford Uni-Flange Section U Romac • Alpha • 600 Series RomaGrip SIGMA • ONE-LOK • PV-LOK Smith-Blair • Bell-Lock • Cam- Lock Star Pipe • Series 1100 • Series 3000 • Series 4000 Tyler TUF Grip SIP EZ Grip

DIP Restraints, Gaskets 4 to 12”	American – Fast-Grip Gaskets Romac Piranha Gaskets Talon Restrained Joint Gasket US Pipe – FIELD LOK 350 Gasket
Fire Hydrants	Clow Medallion Mueller Centurion Waterous • WB77 Trend • WB77 Alpha End
Meter Boxes	
Valve Monuments	
Magnetic Detector and Marking Tape	
Service Line Materials	
Corporation Stops, Unions, Angle Meter Stops DVA Blow off Valves (All Ball Valve Style), Brass service fittings	Ford Jones McDonald Mueller
Service Saddles	Ford • S90, S91, 101B, 202B, F101, F202 McDonald • 3846 Series • 3856 Series Mueller • BR1S • BR2S Romac • 101BS • 202BS
Tracer Wire	
Tracer Wire Connections (must be silicon filled)	

Production Facilities

DIP	American Pacific States US Pipe
DIP Integral Restraint Systems	American • Fastite Flex-Ring • Lok-Ring US Pipe • FIELD LOK • TR FLEX
PVC	Diamond JM North American PW (Pacific Western)
Butterfly Valves	Clow DeZURIK K-Flo/Crispin M & H Mueller/Pratt Val-Matic
Gate Valves	AFC Clow M & H Mueller
Epoxy Coated	Ford JCM PowerSeal Romac
Pipe Restraints, Ductile Iron and PVC	EBAA Iron Megalug • MEGAFLANGE • Restrained Coupling • Series 1100 • Series 1600 • Series 1700 • Series 2000 Ford Uni-Flange Section U Romac • Alpha • 600 Series

	RomaGrip SIGMA • ONE-LOK • PV-LOK Smith-Blair (Cam-Lok) Star Pipe • Series 1100 • Series 3000 • Series 4000 Tyler TUF Grip
Combination Air Release Valves, 3/4 to 4”	Val-Matic
Pressure Reducing Valves, 4 to 12”	
Check Valves, 4 to 16”	
Ductile Iron Fittings	SIGMA SIP Industries Star Pipe Trinity Valley Tyler
Flexible Couplings	Ford JCM PowerSeal Romac Hymac
Corporation Stops, Unions, Angle Meter Stops (Ball Valve Style only)	Ford Jones McDonald Mueller
Pressure Gauges	
Brass Service Fittings	Ford McDonald Mueller